EA Manual Cover

JULY 15, 1941 BULLETIN 176 REV. A

ELECTRO-MOTIVE CORPORATION

SUBSIDIARY OF GENERAL MOTORS

LA GRANGE, ILLINOIS

LOCOMOTIVE OPERATION AND MAINTENANCE
BALTIMORE AND OHIO R. R. SYSTEM
DIESEL-ELECTRIC PASSENGER LOCOMOTIVE
NOS. 51, 57, 58 & 59
(EMC E-522 & E-523)

for

RAILWAY EQUIPMENT

DIESEL MOTIVE POWER

THE CHANGES ON CHANGE NOTICES FOR THE ORIGINAL BULLETIN 175 HAVE BEEN INCORPORATED IN THIS REVISED ISSUE.

Intruction Manual for the Operation of Railway Equipment

B&O EA Diesel Locomotives

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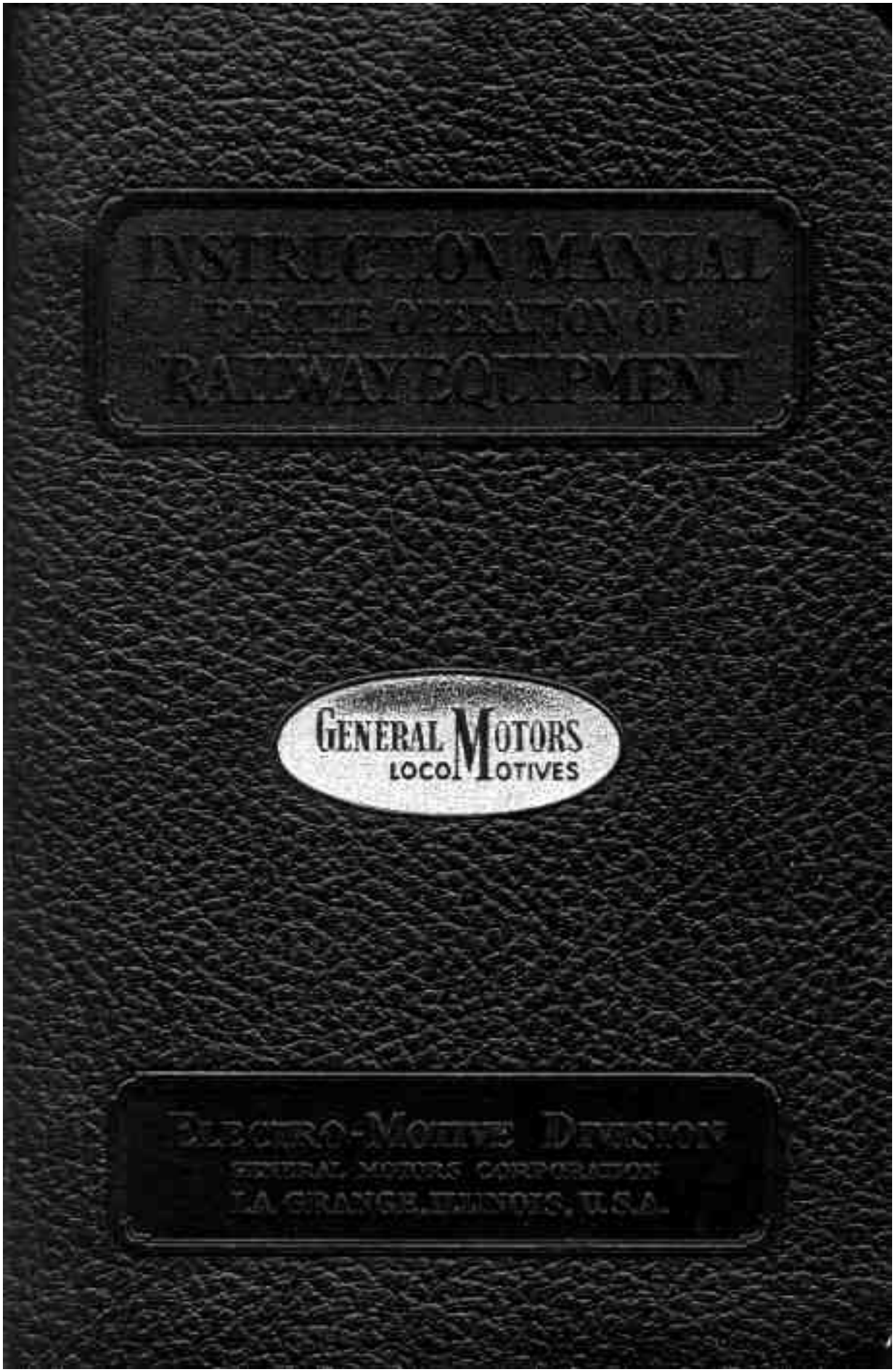
PREFACE

This Bulletin is a manual on the operation and maintenance of the Baltimore and Ohio 2000 H.P. diesel-electric locomotive untis. The units with cabs will be known as "A" units, those without as "B" units. The diesel engine front has been established as the oil and water pump end; the rear as the generator end. (For further engine terminology see Bulletin 150.) The locomotive unit front and #1 end is toward the rear of the engine.

The information contained in service instruction bulletins on individual pieces of equipment is not* duplicated herein, but reference. is made throughout this manual to these bulletins wherein the respective equipment is mentioned. A maintainer , equipped with this master bulletin and a complete set of instruction bulletins, as listed on the "Index to Bulletins" supplied with each set, has, at his disposal, all the available service information on this equipment. For information not found in these bulletins, write the Service Manager, Electro-Motive Corporation, LaGrange, Illinois.

*Lubrication is an exception, See Section VIII.

The information in this bulletin is subject to change without notice. When ordering parts follow instructions given in Bulletin 1703. Refer to Bulletin 1704 for general inspection-Schedules.


GENERAL MOTORS
LOCOMOTIVES

SECTION I - GENERAL DATA

Weight with 1/2 running supplies (approx)	
"A" Unit	301,000 lbs.
"B" Unit	295,000 lbs.
Fuel Oil Capacity (approx)	1200 gals per unit
Lube Oil Capacity (Approx)	110 gals. (Dry System) per unit
Lube Oil Capacity (approx)	100 gals. (Oil Change) per unit
Cooling Water Capacity (approx)	(High Level) 190 gals. per engine
Cooling Water Capacity (approx)	(Low Level) 160 gals.per engine
Boiler Water Capacity (approx)	1000 gals. "A" Unit 1200 gals. "B" Unit
Sand Capacity (approx)	15 cu.ft. "A" Unit 0 cu.ft. "B" Unit
Gear Ratio	22/55
Maximum Permissible Speed	98 M.P.H.
Maximum Negotiable Curve	274' Radius (or 21 deg Curve)
Length "A" Unit between coupler faces	71' 1 1/4"
- - - "B" Unit	70' 0"
Height: Over Horns	15'
- - - -Over Roof	13' 11"
Width: Outside Grab Irons	10' 7"
- - - Over Posts	9' 10"

PIECE OF EQUIPMENT

12-567 Engine	24,500 lbs.
Type D-4 Generator	11,110 lbs.
Exhaust Chamber	150 lbs.
Type A-3001 Aux. Gen w/ Sheaves	755 lbs.
Type ADX Compressor	760 lbs.
Boiler	3,420 lbs.
6 Wheel Truck Comp.	51, 360 lbs.
Traction Motor	6,165 lbs.
Main Hatch	2,281 lbs.
Lube. Oil Cooler	467 lbs.

LOCOMOTIVE OPERATION

PRECAUTIONS BEFORE STARTING ENGINES

- 1. Check position of all valves for correctness.
- 2. Check fuel oil supply.
- 3. Check engine cooling water supply.
- 4. Check lubricating oil supply.
- 5. Check air supply in main reservoir. (Engine stop button not effective unless air pressure is up.)

STARTING ENGINES AFTER MAINTENANCE

- 1. AT DISTRIBUTION PANEL AND LOW VOLTAGE CABINET:
  - a. Be sure all fuses are in place.
  - b. Close main battery switch.
  - c. Close auxiliary generator cutout switch.
- 2. AT MAIN CONTROL STATION:
  - a. Close throttle.
  - b. See that reverser handle is removed.
  - c. Close control switch.
  - d. Close fuel pump switch.
- 3. AT ENGINE:
  - a. Test cylinder accumulation with compression valves open and isolation switch in "start" position, rotate engine once or twice by hand using turning bar. If discharge at relief valve is noted, don't start engine until cause of discharge is removed.
  - b. Close relief compression valves.
  - c. Close fuel pump switch.
  - d. See that isolation switch is in "start" position.
  - e. Push engine "start" button and hold in until engine fires.
  - f. Place isolation switch in run position after lube oil pressure builds up and locomotive is ready to be moved.

TO MOVE LOCOMOTIVE

- 1. Isolation switches on engine control panels must be in "run" position.
- 2. Press in generator field switch.
- 3. Place reverser handle in desired position.
- 4. Release train brakes.
- 5. Set pneumatic control switch.

HANDLING TRAIN

Starting: Make sure and be positive that brakes throughout train are released. Open throttle and leave in #1 position until train slack has been taken, if possible. If no movement of the train in three or four seconds, move throttle to #2 position. At all times allow at least from four to six seconds between throttle positions after train is under way to give engine sufficient time to assume load changes. Come out to 8th position (allowing four to six seconds between notches) to assure transition taking place. Then control train speed as necessary with throttle. When wheel slip light flashes indicating transition, back off on the throttle to a position that will hold the desired speed.

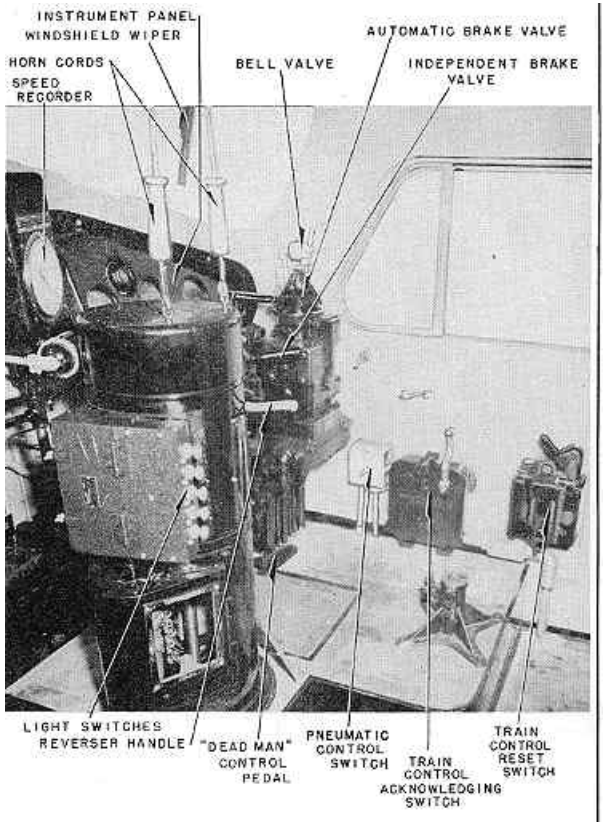
Reduce throttle with three or four seconds between each notch, except in cases of emergency; the close without hesitation.

Reduce throttle to at least #3 position in passing over railroad crossings.

If under normal conditions it is desired to reduce train speeds, such as steadying around curves, etc., and immediately pick up speed again, reduce to #3 throttle position and make required brake application keeping brakes off locomotive. After train speed limit has been adhered to and it is desired to increase speed, release brakes and open throttle again, using required four to six seconds between each position.

When preparing to make station or other stop, bring throttle to idle position using three or four seconds between each throttle position. Make necessary brake application, keeping brakes off locomotive and use judgement regarding speed and distance so as to release and have all brakes just prior to train coming to stop.

Do not apply sand while wheel slip light is burning; reduce throttle until light goes out, then apply sand and open throttle. See Bulletin 1206 for sanding instructions.



CONTROL STATION
"A" UNIT
PLATE 2330

In order to avoid damaging traction motors and generators by excessive heating, the following rules should be observed: --

series-to-parallel transition takes place automatically at approximately 28 MPH. When operating in parallel if the speed drops below 25 MPH it is necessary to return from parallel to series by completely shutting off the throttle to idle and then opening the throttle to desired position.

When operating a 567 powered unit in multiple with a 201-A powered unit, if the speed continues to drop after returning to series as outlined in the paragraph above, it is necessary to *REPEAT* this movement when the speed drops below 20 MPH. Shutting off the throttle the first time at 25 MPH is for the protection of the 567 unit and places both units into series, but the 201-A unit will automatically go back into parallel as the throttle is brought out, because forward transition takes place at approximately 20 MPH on these units, so it is for the protection of the 201-A that it is necessary to return to series a second time when the speed drops below 20 MPH.

The purpose of making this transition from parallel back to series is to protect the generators from excessive current.

With either 567 or 201-A equipped locomotives, train speed can be maintained at 20 MPH for periods not to exceed 12 minutes at full throttle.

In order to avoid excessive traction motor heating, it is important that the weight of the train be kept down so that the speed is not reduced below the following valves when running with wide open throttle:

- 35 miles per hour continuously.
- 30 miles per hour for one hour.
- 28.5 miles per hour for one-half hour.

In general, it is advisable to climb a hill with wide open throttle, in order that the time on the hill be kept as short as possible.

When steam helper service is provided for Diesel powered trains, the procedure necessary for protection of traction motors is entirely different from that used without helpers.

As the train speed is reduced by grade, the Diesel engine throttle must be reduced more and more of the work done by the steam helper.

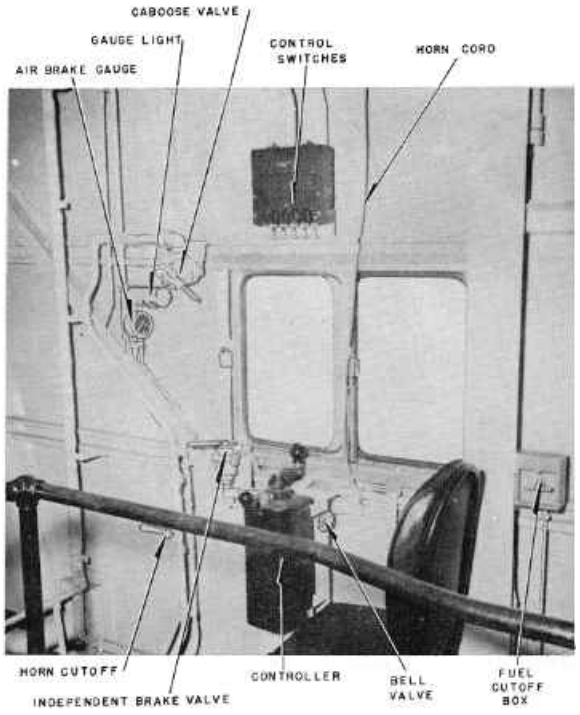
Correct Throttle Position	MPH Continuous Grade	MPH on One Hour Long Grade	MPH on Half Hour Long Grade
8	35	30	24
7	28	25	20
6	22	19.5	15.5
5	16.5	14.5	11.5

PRECAUTIONS DURING LOCOMOTIVE OPERATION

- 1. Maintain engine cooling water temperature of 150 deg - 180 degs. 165 degs is preferred.
- 2. Lubricating oil pressure at 800 RPM should be 35-40#.
- 3. Piston cooling oil pressure at 800 RPM should be 20-30#.
- 4. Control air pressure should be maintained at 80 plus or minus 3#.
- 5. The fuel filter inlet pressure gauge (to indicate the pressure of fuel being delivered from the fuel pump to the fuel filter) should be maintained ar 30-30#.
- 6. It is essential that the batteries be maintained fully charged. Gravity should be 1230 to 1250.

STOPPING ENGINE IN PREPARATION FOR MAINTENANCE

- 1. AT MAIN CONTROL STATION
  - a. Close throttle to idle position.
  - b. Place reverser handle in neutral position and remove handle.
  - c. Open generator field switch.
- 2. AT ENGINE
  - a. Place isolation switch in "start" position.
  - b. Push engine "stop" button and hold in until engine stops.
  - c. Open fuel pump switch.
- NOTE: Engine will not stop unless control air pressure is up.
- 3. AT MAIN CONTROL STATION.
  - a. Open control switch.
  - b. Open fuel pump switch.
- 4. AT DISTRIBUTION PANEL AND LOW VOLTAGE PANEL.
  - a. Open main battery switch.
  - b. Open auxiliary generator cutout switch.
  - c. Remove starting fuse.
- 5. Open compression relief valve on engines.



CONTROL STATION
"B" UNIT
PLATE 2331

STOPPING ONE ENGINE WITH LOCOMOTIVE RUNNING

- 1. Place isolation switch in "start" position.
- 2. Push "stop" button and hold in until engine stops.
- 3. Open fuel pump switch.

PLACING ENGINE BACK "ON THE LINE"

- 1. Close fuel pump switch.
- 2. Place isolation switch to "start" position.
- 3. Push engine "start" button and hold in until engine fires.
- 4. After lube oil pressure builds up, p;lace isolation switch in "run" position. If throttle is wide open hold off on injector linkage to allow engine to come to speed gradually.

TO PUMP UP AIR IN THE MAIN RESERVOIR

- 1. If the locomotive has been standing inoperative and the reservoir have been drained.
  - a. Set hand brake and block wheels.
  - b. Close all drain cocks.
  - c. Place reverser handle in the neutral position.
  - d. Set pneumatic control switch.
  - e. Start engine in the usual way but do not close generator field switch.
  - f. Let engine idle for at least five minutes.
  - g. Open throttle to increase engine and compressor speed.
- 2. If locomotive has been coupled t to train and train line must be pumped up.

- a. Place reverser handle in neutral position.
- b. Set pneumatic control switch.
- c. Pull out generator field switch.
- d. Open throttle to increase engine and compressor speed.

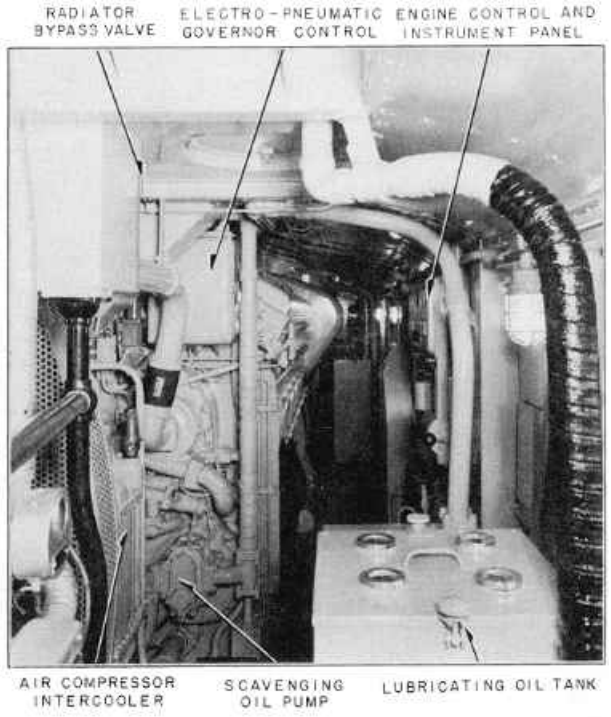
Cases may occur when a failure or delay may be prevented. A few of the things to look out for are:

ENGINE DOES NOT ROTATE WHEN ATTEMPT IS MADE TO START.

- 1. Repeat customary sequence of operations in starting engine, making sure that all controls and switches are in correct position.
- 2. See that main battery switch is closed.
- 3. Check all fuses affecting this circuit.
  - a. Starting fuse. -- This is the large 400 ampere fuse on the distribution panel.
  - b. Main battery or control fuses.
  - c. 30 ampere control fuse. -- This fuse is located opposite the control switches at the control station.
- 4. Battery may be too weak to turn engine over. Turn on engine room lights and note whether they become dim or go out when the start button is pushed.
- 5. Check to see that the starting contactors at the bottom of the low voltage cabinet go in. If not, and the battery is up and all fuses are good, an emergency start may be made by pushing in these contactors by means of two blocks of wood. In doing this, however, *caution must be exercised.* The contactors should be held tightly until the engine starts and the operator's eyes should be averted to avoid possible harmful; effect from flash which may result when the circuit is made and broken.

ENGINE ROTATES BUT DOES NOT FIRE WHEN STARTER BUTTON IS PUSHED

- 1. Check compression relief valves at each cylinder, making sure they are closed.
- 2. Check fuel pressure. If no fuel pressure builds up:
  - a. Check fuse opposite fuel pump switch box at control station, and fuse in engine instrument panel.
  - b. Check to see that fuel pump is running, that the shaft is not sheared nor the coupling broken.
- 3. Check fuel supply.
- 4. Check to see that the emergency fuel cut-off valve is open.
- 5. Check injector linkage in event that it may be stuck in shutdowns position.
- 6. Check to see that overspeed trip shaft is latched in "run" position.



ENGINE ROOM RIGHT SIDE
PLATE 2316

LOCOMOTIVE DOES NOT MOVE WHEN THROTTLE IS OPENED

Some of items listed below would cause a loss of load on one engine. (see next paragraph) which would cause slow acceleration.

- 1. Check pneumatic control switch. (See Section V for details)
- 2. Check hand brake and see that it is released.
- 3. Repeat movement of brake valve to release all brake shoes.
- 4. Check t to see that generator field switch at control station is closed and fuse good.
- 5. Check electric air pressure and see that reverser are in forward or reverse position.
- 6. Check to see that ground protection relays are set in normal position.
- 7. Check all fuses:
  - a. 60 ampere control fuses on the distribution panel.
  - b. 30 ampere control fuse opposite the control switch at the control station.
  - c. 60 ampere battery field fuse in the low voltage cabinet.
  - d. 15 ampere field fuse in the low voltage cabinet.
- 8. The generator or battery field contactors may be open, or making poor contact.
- 9. The auxiliary generator armature or field fuse may be burned out. Without the auxiliary generator charging, there is apt to be a weakened main generator battery field.
- 10. If a starting contactor sticks shut, the generator of that power plant will not deliver power.

LOSS OF LOAD ON AN ENGINE

To detect a loss of load on an engine, look at the load indicator on the governor. After the engine and generator have had a chance to balance up (about 30 seconds) the load indicator should agree with the indicator on the back of the electro-pneumatic governor control. If the indicator on the governor is low, it may be showing:

- 1. The motors across that generator are in series while the other power plants are in parallel.

- 2. The BP or SF contactors are out. This may be caused by:
  - a. Ground relay tripping.
  - b. Starting contactors stuck shut.
  - c. Wheel slip relay contacts dirty or open.
- 3. Battery field fuse blown.
- 4. Dirty or poorly made contacts any place in the power or generator field circuits.

In correcting any of these defects it is important that the power plant being worked on is isolated.

AMMETER SHOWS DISCHARGE

- 1. Check all fuses in circuit affected.
  - a. 30 ampere auxiliary generator field fuse in the low voltage cabinet.
  - b. 150 ampere battery charging fuse in the low voltage cabinet.
- 2. Auxiliary generator drivebelts may be loose or broken. In this case, or if replacing fuses is not corrective, the maintainer should be notified and condition corrected.

AIR PRESSURE DOES NOT BUILD UP

- 1. Check to see that angle cocks and main reservoir drain valves are closed.
- 2. Check main reservoir safety valve in event that it may be stuck open and a light tap may seat it.
- 3. Blow out filter and air compressor governor mounted on the rear wall of the engine room.

LOCOMOTIVE BUCK

- 1. If the locomotive moves, but its motion is uncertain, check:
  - a. Belt tension to auxiliary generator.
  - b. Generator field contactors not actually closing.
  - c. Some pieces of equipment may be *flashing over.

LOCOMOTIVE STOPS IN OPERATION

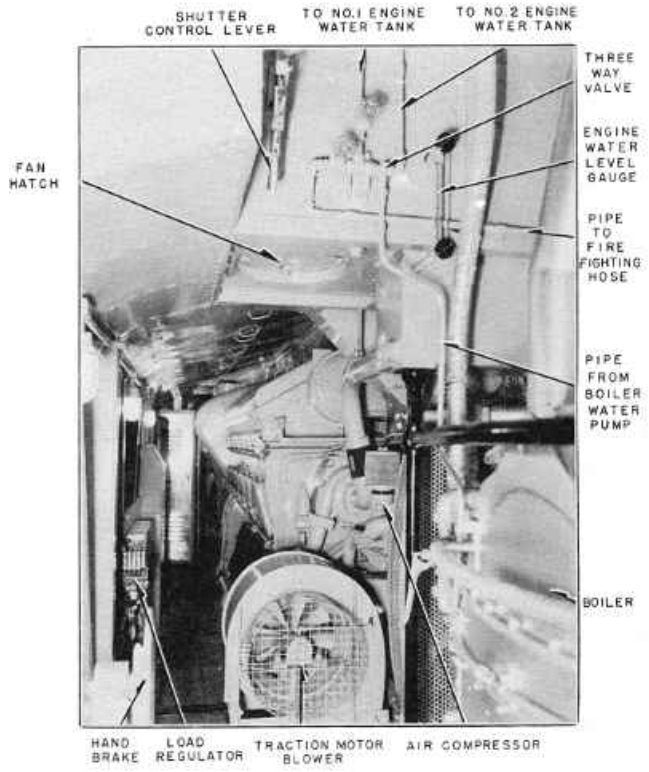
1. If the locomotive suddenly becomes inoperative, immediately check the control fuses (60 A) on the distribution panel, then check the control fuse on the box on the control station. The unit switches may be opened because of low air pressure. A wire may have been jarred loose, or may be burned off. The fuel supply may have stopped. Ground relays may be open.

ENGINE FAILS TO SPEED UP WHEN THROTTLE IS OPENED

Low oil pressure switch may be in start position. A 60 ampere or 30 ampere control fuse may be defective. Control switch may be out.

ENGINE FAIL TO STOP

If the engine fails to stop when the throttle is placed in shut-down position check for binding linkage, inoperative governor control, faulty governor, or defective "E" master valve. Stop engine with a governor barring down tool.



ENGINE ROOM LEFT SIDE
PLATE 2315

STANDING IDLING AND COLD STARTING

When the standing time exceeds ten minutes, we would recommend that the engine be shutdown and started up again when required, allowing just sufficient time to pump up the necessary air, should it have dropped below operating pressure.

On cold engines or engines that have stood over night, it would be desirable to operate them at 450 RPM for approximately one-half hour, this or course, with all shutters closed so that engine will warm up in a minimum time.

RUNNING THROUGH WATER

Under absolutely no circumstances should the locomotive pass through water which is deep enough to touch the bottom of the motor frames. When passing through water, always go at very slow speeds (2-3 miles per hour).

LACK OF POWER

In the engine this may be due to poor combustion, insufficient air, improper fuel, restriction in exhaust, incorrect timing, leaky exhaust valves, or a tight bearing or piston.

In the electrical system lack of power may be due to low generator field excitation. Low generator field excitation may be due to a faulty connection in the generator battery field circuit, a faulty auxiliary generator, a weak battery or an open generator field contactor. Lack of power may also be due to faulty traction motors or generators, transition relay, or traction motor contactors.

In short, anything preventing the generator from delivering its full output or preventing the traction motors from delivering their full power will cut down on locomotive speed.

EXHAUST SMOKE

Smoke at the exhaust is usually an indication of poor combustion of fuel but may be due to excess lubricant passing into the combustion chamber. Fuel in a partially burned condition will cause a black exhaust. If the fuel is not igniting the exhaust may show blue. Smoke may appear at light loads or upon starting due to low temperature of the combustion chamber. Misfiring, improper fuel, incorrect timing, a faulty injector or insufficient air, may be the cause of exhaust smoke.

Smoke may also be an indication of continuous engine overload due to improper pilot valve adjustment, plugged pilot valve feed line, or inoperative load regulator.

SPARE SUPPLIES

See that the supplies are replenished as spare stock is used. There must be adequate supply of spare fuses, lamps, lintless rags (never waste), drinking water, generator and motor brushes, injectors, lubricating oil, etc. Keep the fire extinguishers full and in working condition.

SAFETY DEVICES

Certain pieces of equipment are provided for safety purposes. Theses include:

Pneumatic Control Switch	See Section V
Emergency Fuel Cutoff	See Section IV
Engine Overspeed Trip	See Bulletin 150
"Low Oil" Alarm	See Section V
"Hot Engine" Alarm	See Section V
"Boiler Stopped" Alarm	See Section V
"Wheel Slip" Light	See Section V
"Hot Journal" Alarm	See Section V
"Dead Man's" Pedal	See Air Brake Manufacturer Instructions
Boiler Protective Devices	See Bulletin 2405
Fire Extinguishers	See Section VII
Hand Brake	See Section VII
Safety Gates	See Section VII
Engine Safety Grilles	See Section VII

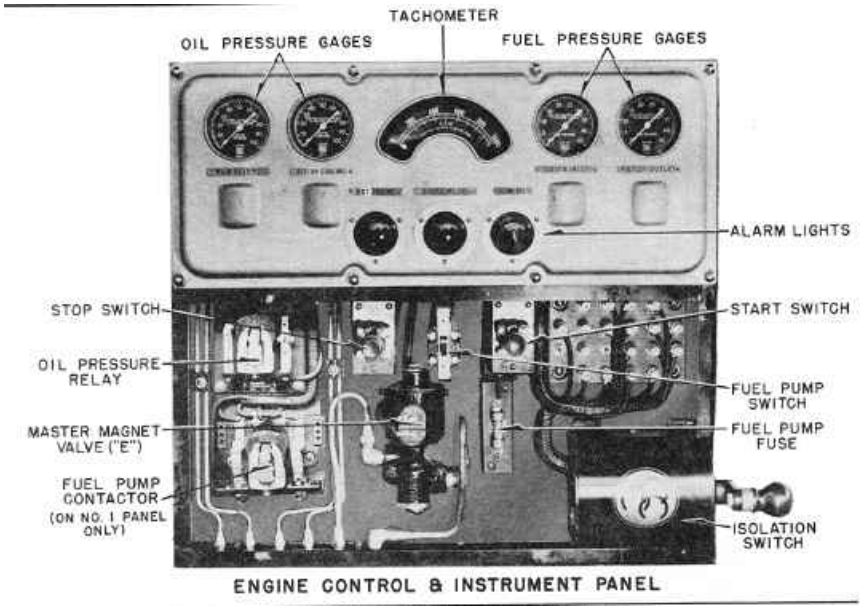
See Bulletin 1702 for Safety Hints.

DEAD HEADING

- 1. Be sure reversing handle is in neutral when a unit is being towed.
- 2. For setting of brakes see the Air Brake manufacturer's instruction.

CLEANING ENGINE ROOM

Keep the engine room clean. For details see Bulletin 1706.



ENGINE CONTROL & INSTRUMENT PANEL

PREVENTIVE PROGRESSIVE MAINTENANCE AND CLEANLINESS EQUALS HIGH AVAILABILITY PLUS LOW MAINTENANCE COSTS

Due to the manner in which Diesel power, both switching and main line, was introduced to the railroads (via the gas-electric motor cars) very little serious thought has been given by the railroads to separate and distinct maintenance organization. This is particularly due to the fact that the original gas-electric cars were a combination of motive power and coach, and in most instances were "taken care of" on a side track near the roundhouse, or in the coach yard.

The facilities provided were available water, a storage tank for gasoline, in some instances a small shed for tools and a few spare parts. The man power consisted of machinists and electricians whose normal duties were the maintenance of steam locomotives, and these men in turn were trained by the manufacturer's representatives.

The evolution of the gas-electric motor car to the present diesel switching, transfer and main line locomotives, only changed this picture to the extent that they were considered locomotives, and were placed in steam engine roundhouses to be maintained along with the steam engines.

It is obvious that the maintenance of steam locomotives requires a high degree of skill in addition, a knowledge of both electricians and machinists trade is desirable for the best results, since proper operation of the locomotive depends on coordination of the Diesel engine and the electrical transmission.

Due to the smaller clearances and bearing surfaces employed in the Diesel engine it is essential that any repair work must be done under absolutely clean conditions. Any dirt introduced into the engine will cause trouble and result in increased maintenance cost.

We feel that it is the responsibility of the Railroad to provide facilities which will enable the Diesel maintenance forces to meet the standards of cleanliness which the equipment requires. If this is done we felt that it is relatively easy to educate men to live up to the standards of cleanliness required.

Naturally, if men are regularly assigned to this work and the work is arranged so that a few men can accomplish the job, the results will be much better than if the work is put off until a major operation must be performed and a large number of men, who are unfamiliar with it, are assigned to get the job back into service.

From the standpoint of the Management, after the provision of a clean shop the only other thing remaining to be provided is a small number of tools which are easily justified from the saving in maintenance time and maintenance cost.

To provide the proper training, we have a school at our LaGrange plant which is open to all railroad mechanics and electricians and an Instruction Car that is on the railroads most of the time. This offers a two-week course in the fundamentals of the Diesel Engine, Electric Control and Transmission. There, of course, is no charge for this training.

To obtain the desired high availability and low maintenance costs on Diesel power, it is necessary that a preventive and progressive maintenance schedule be laid out and carefully followed.

Our power plants were designed after giving serious thought to the type of maintenance they would require and the limited amount of time in which to do this maintenance. Therefore, each cylinder is more or less of a complete engine in itself.

With this in mind it is possible and very practical to overhaul one or more cylinders at a time, without affecting in any manner the performance or operation of the balance of the engine, making it possible to completely overhaul all cylinders in an engine during the monthly inspection period on switch engines, or during short layover periods of mainline power.

This can be done by removing one or two pistons, cylinder heads, bearings, etc., at each monthly inspection of a switch engine, and at definitely designated turn-around periods fro a mileage standpoint of road power. If handled in this manner, it will eliminate the necessity of completely disassembling an engine for this work at the annual inspection period.

It has been proven quite conclusively that by following the progressive maintenance program, it will only require about 60 percent of the time to do the same amount of work as would be required if the complete power plant were disassembled. This is due particular to the fact that so many other things interrupt the work on a completely disassembled engine.

In addition to this, if the progressive maintenance program is followed properly, the availability loss is practically negligible, as the necessary engine work can be handled during the regular 8-hour monthly inspection work.

There is also a decided advantage in the progressive maintenance setup at the annual inspection period owing to the fact that by the time the bearing have had their annual inspection. Therefore, the annual inspection of the balance of the locomotive is really a polished up monthly inspection, and it should not be necessary to hold the locomotive out of service more than 24 hours for the annual inspection.

The removal of traction motors for inspection, or driving wheels for turning, can also be staggered during the year, to prevent an extensive work on the trucks at the annual inspection.

On railroads which have followed this scheme, it is quite evident from their availability and maintenance costs that this is the most desirable scheme to follow.

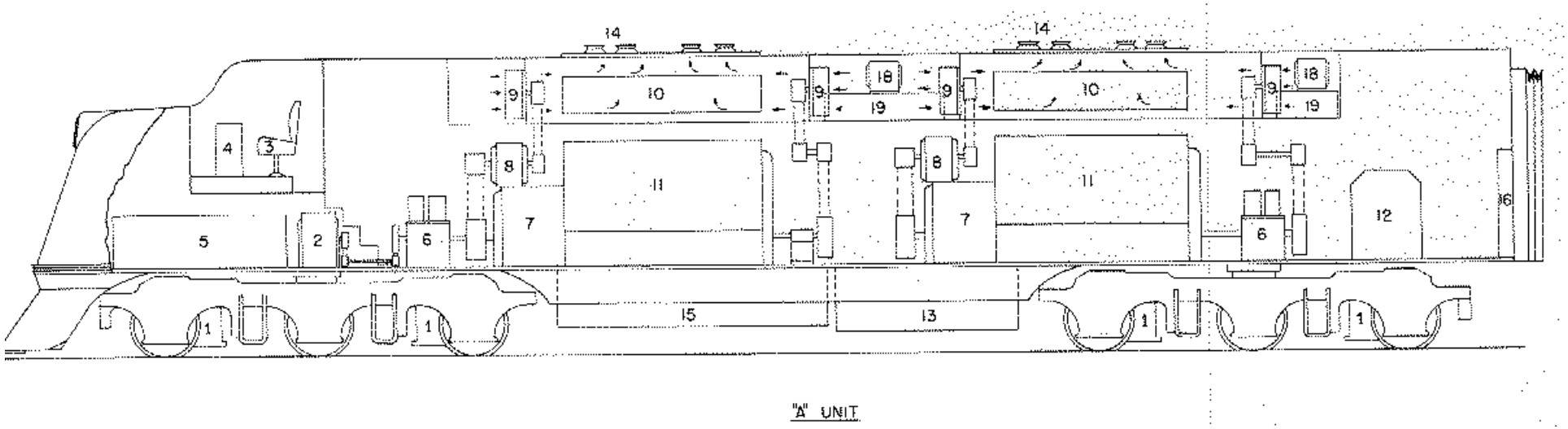
If the maintenance work is distributed over the entire year, the maintenance force have more frequent opportunities of checking into the engine, which will prevent many series failures that prevail where an attempt is made to run the engine for an entire year without other than ordinary tightening up, etc.

We have found numerous instances where locomotives have been held out of service for certain repairs which, for one reason or another, were not completed in the 8 hours worked by the shop crew, and instead of working overtime to finish the locomotive and get it back into service, the locomotive has lain idle in the shop for 16 additional hours waiting for the next regular trick to finish the work. It is quite evident in these instances that the economy of the locomotive has been given little consideration. If a careful study were made, it would be found that it is far more economical to work overtime to get a Diesel switcher back into service than it is to penalize the availability and economies by holding it out of service.

Some of the railroads have developed an inspection scheme that calls for weekly inspections of the locomotive, holding it out as much as from 4 t o8 hours semi-monthly, while our recommendations are that the locomotive be given a monthly inspection only.

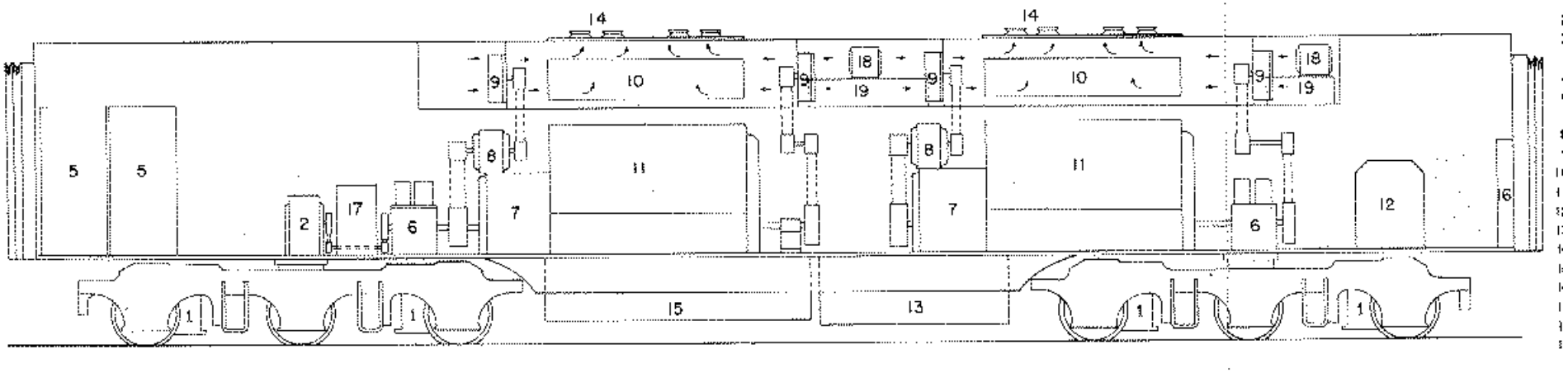
This does not estimate, of course, the practice followed by some railroads where they have sufficient Diesel switchers in operation to justify one man circulating among the switch engines daily and giving them a daily 15-minute check-over, without taking them out of service.

See Bulletin 1704 for Maintenance and Inspection.



General Arrangement - "A" Unit

1	Traction Motor	7	Main Generator	13	Fuel Tank
2	Traction Motor Blower	8	Auxiliary Generator	14	Exhaust Stacks
3	Engineer's Seat	9	Engine Cooling Fans	15	Batteries
4	Control Stand	10	Engine Cooling Radiators	16	Boiler Control Panel
5	Boiler Water Tank	11	Diesel Engine	17	Distribution Panel
6	Air Compressor	12	Train Heating Boiler	18	Lube Oil Cooler
				19	Cooling Water Tank



General Arrangement - "B" Unit

Section II

Cooling and Heating Systems

FILLING THE COOLING SYSTEM AND BOILER WATER TANKS

Since the cooling system of the two engines in each locomotive unit are absolutely independent, each must be filled separately. Distilled water or filtered rain water should be used in the cooling systems. Each cooling system is filled either through the filler pipe located on the roof above the water tank, or through one of the two filler pipes alongside the fuel tank. It is necessary to remove the cap to get water into the filler pipe on the roof. (Do not put water in the exhaust stacks).

In warm weather, the cooling systems should be operated with radiators full. That is, when filling, the low level valves "A" should be closed and left closed, and the systems filled until water runs out a filler pipe. The low level valves "A" must be closed at all times. The cooling system capacity is approximately 100 gallons per engine with cooling system at "high level".

In freezing weather, the cooling systems should be operated at "low level". That is, when filling, the low level valves "A" should be open. Fill the tanks until water runs out the low level pipe. The low level capacity per engine is approximately 130 gallons. Close the low level valves "A" before starting the engine.

Never add cold water to a hot engine, unless hot water is not available and then *very slowly, with the engine idling.*

The boiler get its water from the boiler water tank. This is filled from either side of the locomotive, and is entirely independent of the engine cooling system. The boiler water capacity is approximately 1000 gallons per "A" unit and 1200 gallons per "B" unit.

CHECKING CIRCULATION

The engine water outlet manifold thermometer provides an excellent means of detecting an irregularity on the operation of the cooling system. High temperature indicates faulty circulation or lack of water. "Palm of the hand" examination of various points in the cooling system is an excellent check on water temperatures.

The pressure gauge on the outlet side of the water pump should be observed periodically as a check on the operation of the cooling system. A high pressure indicates that the cooling system is filled with scale. A low pressure would indicate that the pump was not operating properly. The pressure at 800 RPM with the cooling system clean would be approximately 23 lbs,; at idle 4 to 6 lbs.

WATER TANK LEVEL GAUGE (ENGINE WATER>

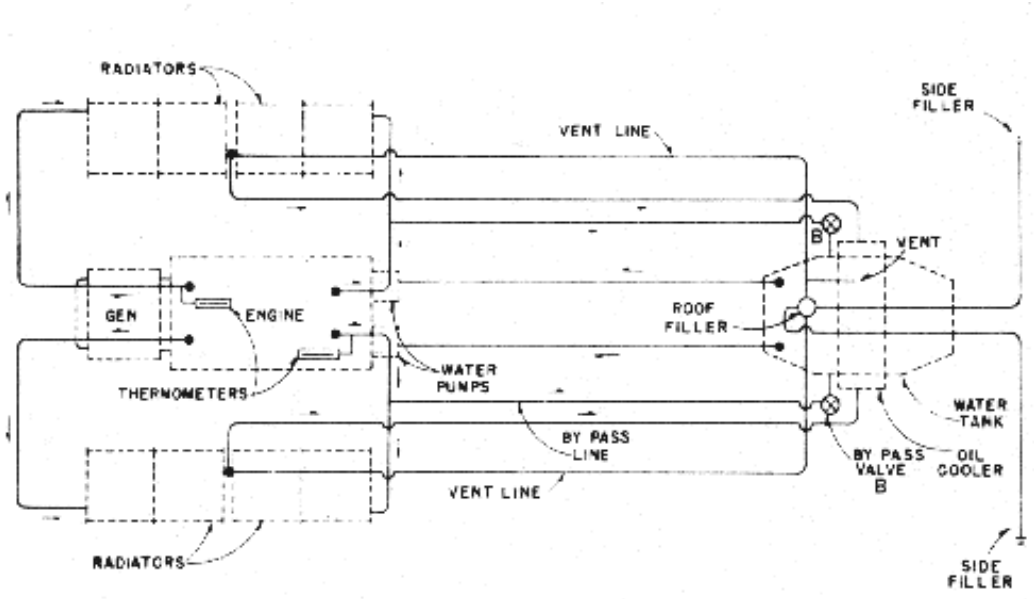
On the left side of the rear of the #2 engine water tank and on the right side of the #1 engine water tank is the water level gauge showing the level of the water in the cooling water tank. The circular hatch must be removed to see the #1 engine water tank gauge. The level gauges should be full when operating with which "high level" and should be below full when operating at "low level".

BOILER WATER LEVEL GAUGE

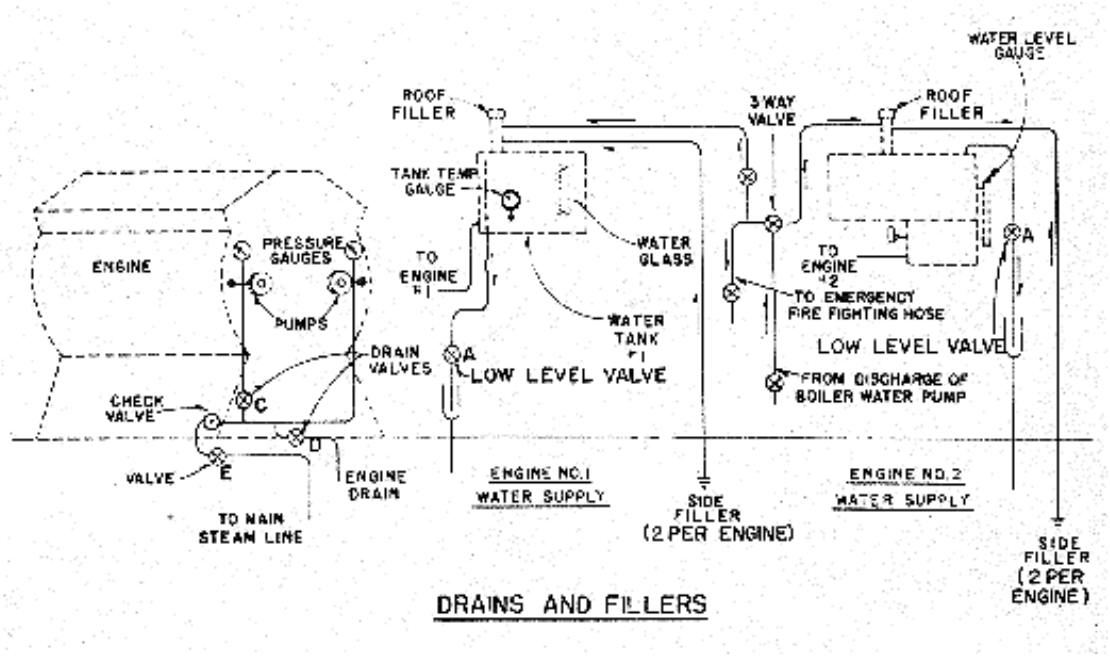
The operation of these remote type liquid level gauges is similar to the fuel level gauges. See "Fuel Level Gauge:, Section IV.

OPERATION

At all times during the operation of the locomotive, the by-pass valves "B" are to be closed. The outlet manifold thermometers and the water tank temperature gauges provide a means of checking the temperature of the cooling system. 165 degs F. is the ideal temperature; a tolerance of 15 degs F. is allowable. Temperature is controlled by the shutter lever which is connected directly to the shutters. Opening the shutters lowers the temperature of the engine's cooling water. During winter months, only a very small shutter opening is required. When leaving locomotive for any length of time, the shutters should be closed all the way. Every 10,000 miles check the operation and wear of the shutter mechanism. The temperature gauges, thermometers and engine temperature switches should be tested every 50,000 miles.



Schematic



Cooling Water Piping

FREEZING WEATHER PRECAUTIONS

Do not use any kind of anti-freeze solution in the cooling system. If the water is to be drained, open all drain valves. In addition to the cooling system drain valve, there are drain plugs in the water pumps. If the cooling system is not to be drained, heat from an external source of steam or from the boiler must be supplied. The cooling system of each power plant has a connection with the main steam line. The check valve prevents the cooling water from draining into the steam line.

If the locomotive is out of service during freezing weather, steam must be injected into each cooling system from the steam line by opening valves "E" and "C".

Since the water level is at the low level, the overflow valves "A" on each engine must be open when using steam, otherwise the condensing steam will gradually fill the radiators and they may freeze. By-pass valves "B" (two per engine) must also be open in order to provide complete circulation. Pressure in steam line must be at least 50# and may be obtained either from the steam generator, or an external source through the train line. If two or more units are coupled only one steam generator need be used, but if separated, the steam generator in each must be operated, unless steam is supplied from external source.

Thermometers on the engines must be watched and maintained at 100 to 170 degs F. (This temperature applies only when using steam.)

If the engines are idling in extremely cold weather, it may be desirable to admit steam as above except that by-pass valves "B" must be closed and the radiators felt periodically by hand to make sure they are warm at all points.

When it is desired to place locomotives in service again, close by-pass valves "B". Leave overflow valves "A" open with engine shut down until no water runs out, THEN CLOSE. Start engines and by feeling the radiators by hand, make sure the water is flowing through all sections of them. They will be warm if the water is

flowing. Do not start engines during freezing weather with the by-pass valves "B" open.

To heat the boiler in freezing weather, open the steam valves shown on Plates 2290 and 2291.

There are drain valves for the boiler, boiler water tank, and boiler water feed line which must be opened if the system is not heated in freezing weather. (See Plates 2290 and 2291.)

REPAIRING FANS AND BELTS

Refer to Parts Bulletin 941.5 (A Unit) and 943.5 (B Unit).

Refer to Bulletin 904 for repair information on belts.

FLUSHING COOLING SYSTEM

For the removal of *scale formation only,* Oakite #32 may be used. Due to the presence of oil or from any oil leaks which may be present, it is necessary to first circulate a solution of Oakite Penetrant, at a strength of 3 oz. per gallon, for a period not to exceed 30 minutes, after which the system is drained, refilled and flushed out with clean water.

Following this operation, a solution of 10% by volume of Oakite Compound #32 should be circulated by idling the engine for a period not exceeding 30 minutes. Engine temperature should nor exceed 140 degs F. Oakite Products will furnish apparatus for checking the strength of the solution and will furnish additional help and information.

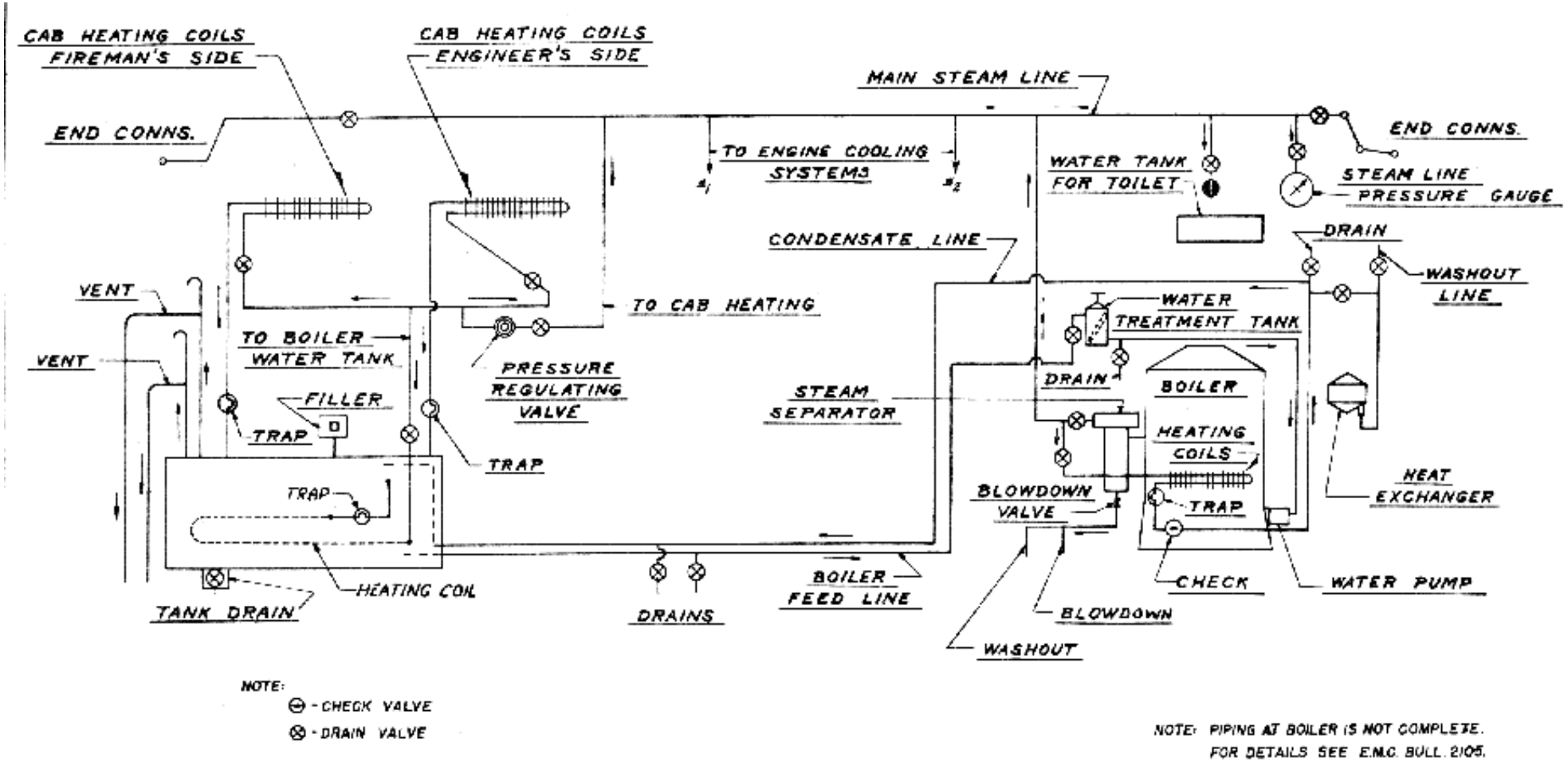
If there is any appreciable amount of scale present in the cooling system, same will react with the Oakite solution, weakening the strength of the solution. Therefore it may be necessary to add Oakite compound #32 while cleaning the engine in order to maintain proper strength of the solution. A check as to the strength of the solution can be made by titration. It is our understanding that Oakite Products have a titration set for this purpose which is available to their customer.

After this operation, the system is drained and filled with a solution of 2 oz. per gallon of Oakite Penetrant to *thoroughly neutralize the acidity* of the system. The solution should be circulated for 10 to 15 minutes, then drained out and refilled with clean water for normal operation.

We wish to point out the Oakite is an acid and will attack the metals in the cooling system, especially the aluminum and cast iron, and for this reason, must be handled with care and completely neutralized with Penetrant compound; otherwise, serious damage may result. It is to be used only for the removal of scale and then not oftener than necessary. An examination of the cylinder liners and other parts of the cooling system will indicated when it should be used. If it use is necessary *oftner than every six months* to remove scale, *the water supply should be changed.*

For the removal of other foreign matter, such as mud, etc., flushing at regular intervals should be satisfactory. If, however, flushing does not keep the system clean, especially the radiator headers and radiators, they should be removed every six months, or as often as necessary to keep the radiator clean; otherwise cooling troubles will result.

The condition of the rubber hoses should be checked every 10,000 miles.



Steam and Boiler Water Piping Diagram

BOILER OPERATION

Refer to EMC Bulletin 2105 covering the operation and maintenance of the boiler type CFA4225.

Flush the boiler approximately once a month with a boiler washing machine as described in EMC Bulletin 2105.

CAB TEMPERATURE

The temperature of the cab in cold weather can be controlled by two valves, located in the cab, one under each seat. There is also a valve in the steam line located under the cab floor.

DRAINING COOLING SYSTEM

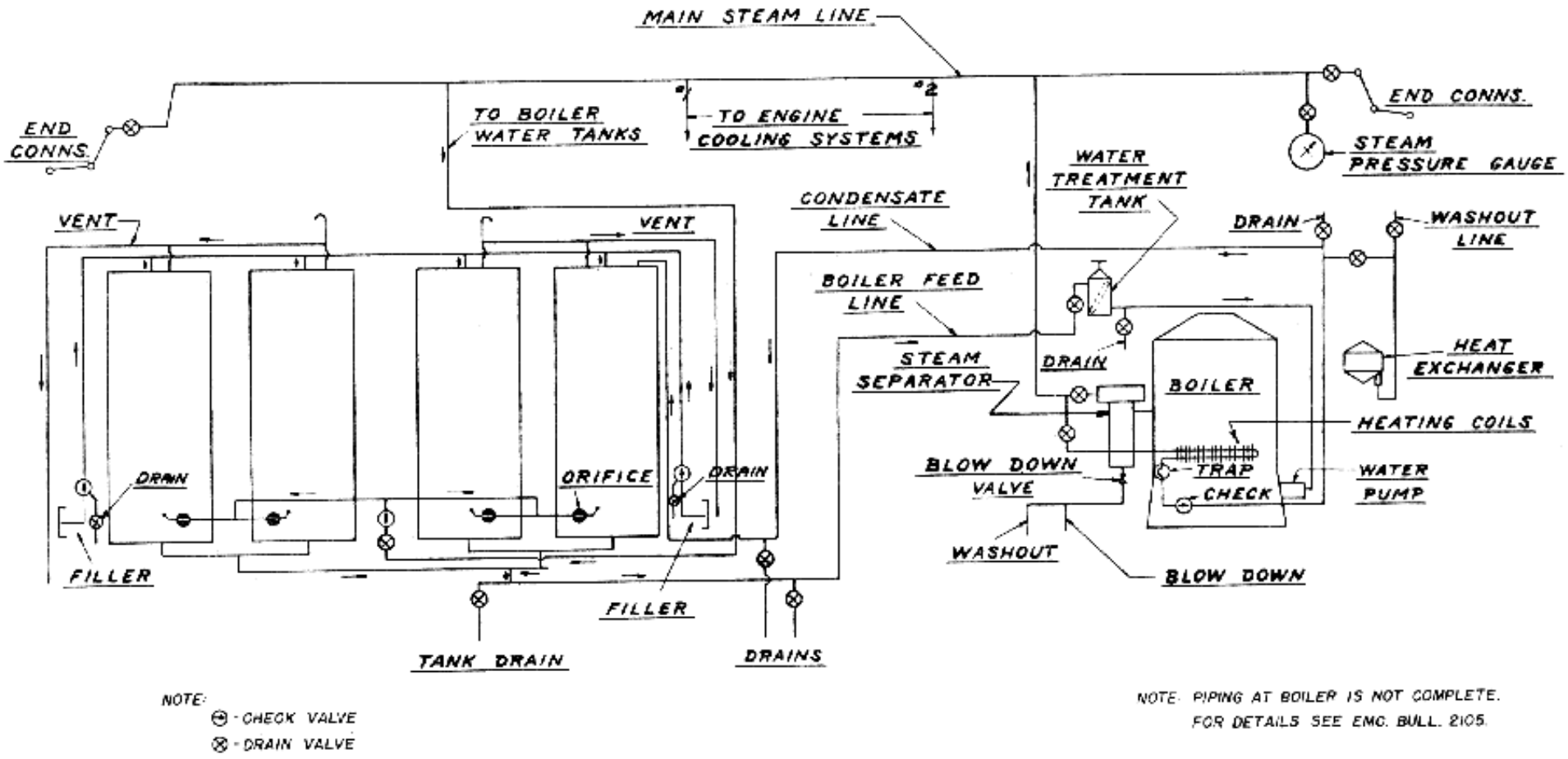
Each engine has a completely independent cooling system so each engine must be drained separately. Open drain valve "C" and "D". A small amount of water will be trapped in each water pump, unless the drain plugs at bottom of water pump housing are removed.

CLEANING RADIATOR

If hard water is used in the cooling system, it may be necessary to remove the intake headers from the radiators and remove any deposits every six months in addition to flushing the cooling system. New gaskets should be installed when replacing the headers.

EMERGENCY WATER SUPPLY

In the event that the water level becomes low in either the #1 or #2 engine cooling system, water can be obtained from the boiler by opening the proper valves. (See Plate 2263). Also the boiler water supply can be used to fight fire by opening valves to the hose reel.



Steam and Boiler Water Piping Diagram - "B" Unit

Section III

LUBRICATING OIL SYSTEM

FILLING OIL SYSTEM

If equipment has stood a long time, pour some oil over the rocker arms and other moving parts. Put approximately 90 gallons into the tank. Then run the engine for several minutes. Shut down the engine and add whatever oil is necessary to bring the level in the oil tank to the "full" mark.

Total lube oil required per engine oil change approximately 100 gallons. Total lube oil required for dry system approximately 110 gallons. See Bulletin 150 for oil specification.

DRAINING OIL SYSTEM

Open the drain valve "A" outside the locomotive then drain the engine sump by removing a hand hole cover and removing the drain plug. Drain the oil tank by opening the drain valve "B" just in back of the oil tank. Drain the overflow line by opening valve "C". When the oil stops draining, close all valves tightly. Make sure. The air reservoir drain valve "D" should be closed when the locomotive is in the depot.

It is our recommendation that the lubricating oil be changed at approximate intervals of 25,000 miles. When the assignments of the locomotive are such that runs terminate at slightly less or slightly greater mileage than this figure, oil should be changed at the greater mileage.

At any time that it is necessary to remove pistons or cylinder liners because of scoring, crankcase and lubricating oil system of the engine should be drained and flushed so as to eliminate any particles of metal which may be circulated through the engine in the lubricating oil. This action is taken as a precautionary measure to avoid the possibility of souring other cylinders of the same engine, or the possibility of the particles finding their way to the main or connecting rod bearings, etc., of the engine, imbedding themselves in the bearing metal and giving the bearing surface an abrasive finish.

LUBRICATING OIL PRESSURE

Lubricating oil pressure must be maintained at all times. When starting a cold engine, allow it to idle for some time and see that pressure starts to build up almost immediately. The pressure may rise on a cold engine to around 50 pounds, and should run around 35-40 lbs. at 800 RPM with the engine warm. At idling, pressure should be at least 15-25 lbs. with the engine warm.

PISTON COOLING OIL PRESSURE

The piston cooling oil system has no relief valve, so pressure is dependent upon oil temperature, viscosity and engine speed. Usually pressure will be 20 - 30 lbs. at 800 RPM and 4-6 lbs. at idling with a warm engine.

SCAVENGING OIL PRESSURE

There is no gauge connected to the scavenging oil pump. A 50 lb. relief valve across the oil cooler provides a by-pass for the oil in case the oil cooler becomes clogged. The covers on the oil filters (Plate 2325 Ref 4) are relief covers which will lift at 20-25# in case the filters become clogged.

ENGINE LUBRICATING SYSTEM

This includes the oil pumps, relief valve and oil pan. For details see Bulletin 150.

OIL COOLER

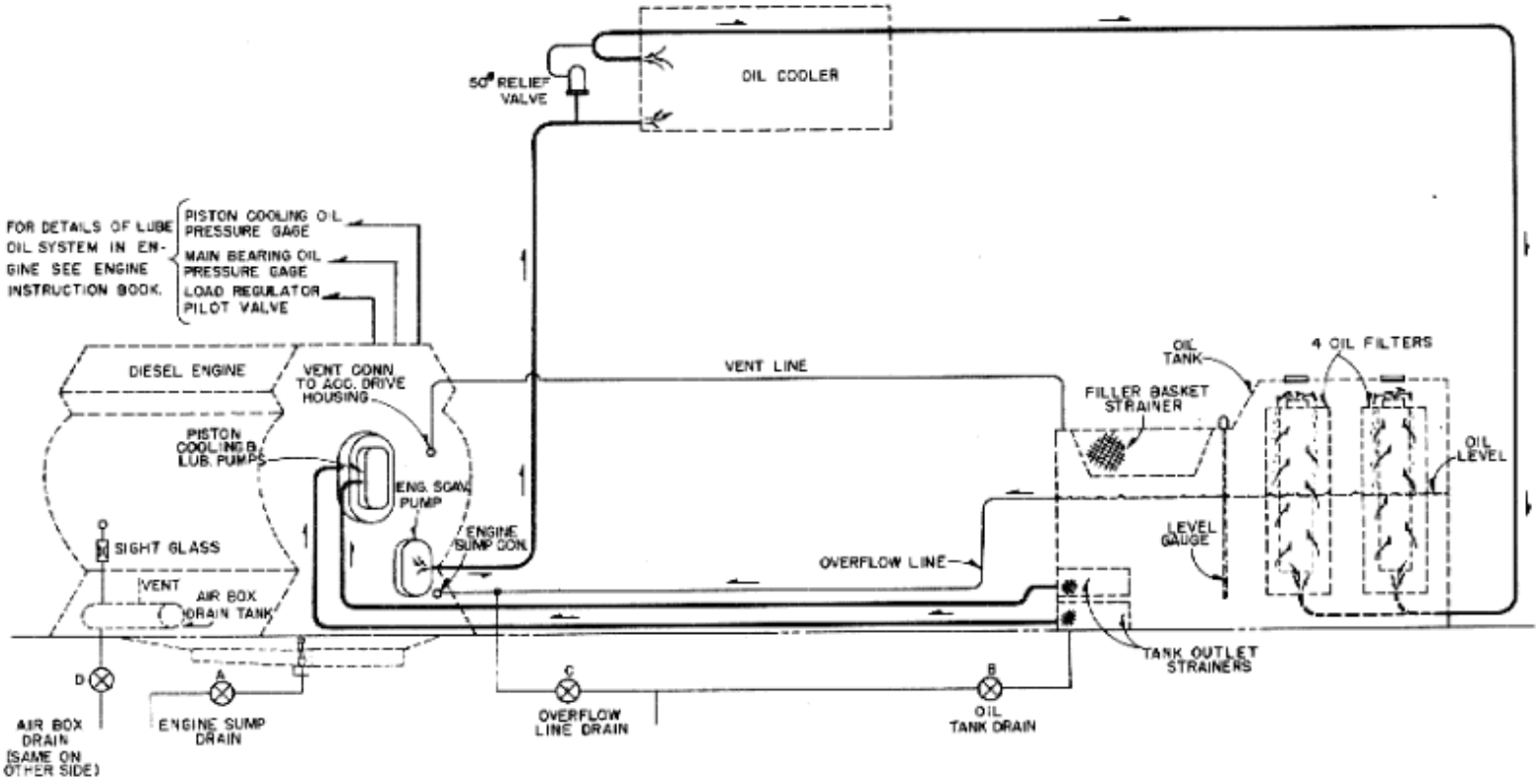
Coolers should be cleaned about every 100,000 miles. For details see Bulletin 1706.

The gaskets between the oil cooler core unit and the oil cooler housing tend to compress after a short period due to heat and vibration. This allows oil to enter the cooling system and is often mistaken as an indication of a broken oil cooler core.

Therefore, *ALL* nuts on the cooler should be tightened every 50,000 miles or until there is no indication of leakage. This should also be done after an oil cooler core has been replaced with a new one.

LUBRICATION TROUBLES

No oil in reservoir may be caused by an open drain valve or inoperative scavenging system. Failure of scavenging lines may be due to a broken oil connection, a loose connection causing an air leak, a bad oil pump, or a clogged sump strainers. If relief valves stick open, inspect for dirt lodged on the seat. Low oil pressure may be due to a broken header, clogged strainers, excessive bearing wear, excessive pump wear, diluted lubricating oil, or leaky oil lines.



SCHEMATIC LUBE OIL PIPING DIAGRAM

DILUTION

It is possible for fuel oil to get into the lubricating oil if a fuel line inside the head is loose or broken. The viscosity of the lubricating oil should be checked, if such a condition has existed. Check lubricating oil viscosity every 10,000 miles. A tool is available for this. See Bulletin 1702.5.

LOW OIL PRESSURE SHUT DOWN SWITCHES

If the piston cooling or lubricating oil pressure fails, the oil switch mounted on the respective oil pump section will open, de-energizing the oil pressure relay which de-energizes the "E" master magnet valve, bringing the engine to idle. (See wiring diagram.) For details of the oil pressure switches, see Bulletin 150. If one of these switches operates do not run the engine until the trouble has been corrected.

FILTERS

The filters (four per engine) clear the oil of sludge and dirt but cannot remove any fuel oil which may get mixed with the lubricating oil. For maintenance, see Bulletin 1604.

The filter elements are supplied with handles which must be removed before installing the filters. Save the handles for use in carrying the elements after they are removed. The remove an element remove upper spring seat (Plate 2325, Ref. 6) with a wrench. Then remove spring 5 and cover 4.

When the lubricating oil begins to assume a dark or dirty color the elements should be changed in the filter, inasmuch as a good lubricating oil filter when properly maintained should keep the oil clear and free from any appreciable discoloration. We recommend that all four elements be changed at the same time after each 5000 miles of service, unless experience indicates that they should be changed oftener.

EXCESSIVE OIL CONSUMPTION

This may be caused by a leak, broken or stuck rings, worn pistons, oil too thin, loose piston pin caps, improper grade of oil, excessive oil pressure, clogged oil drain holes in piston.

LITTLE or NO OIL CONSUMPTION

This may be due to too heavy an oil, or water or fuel leaking into the oil.

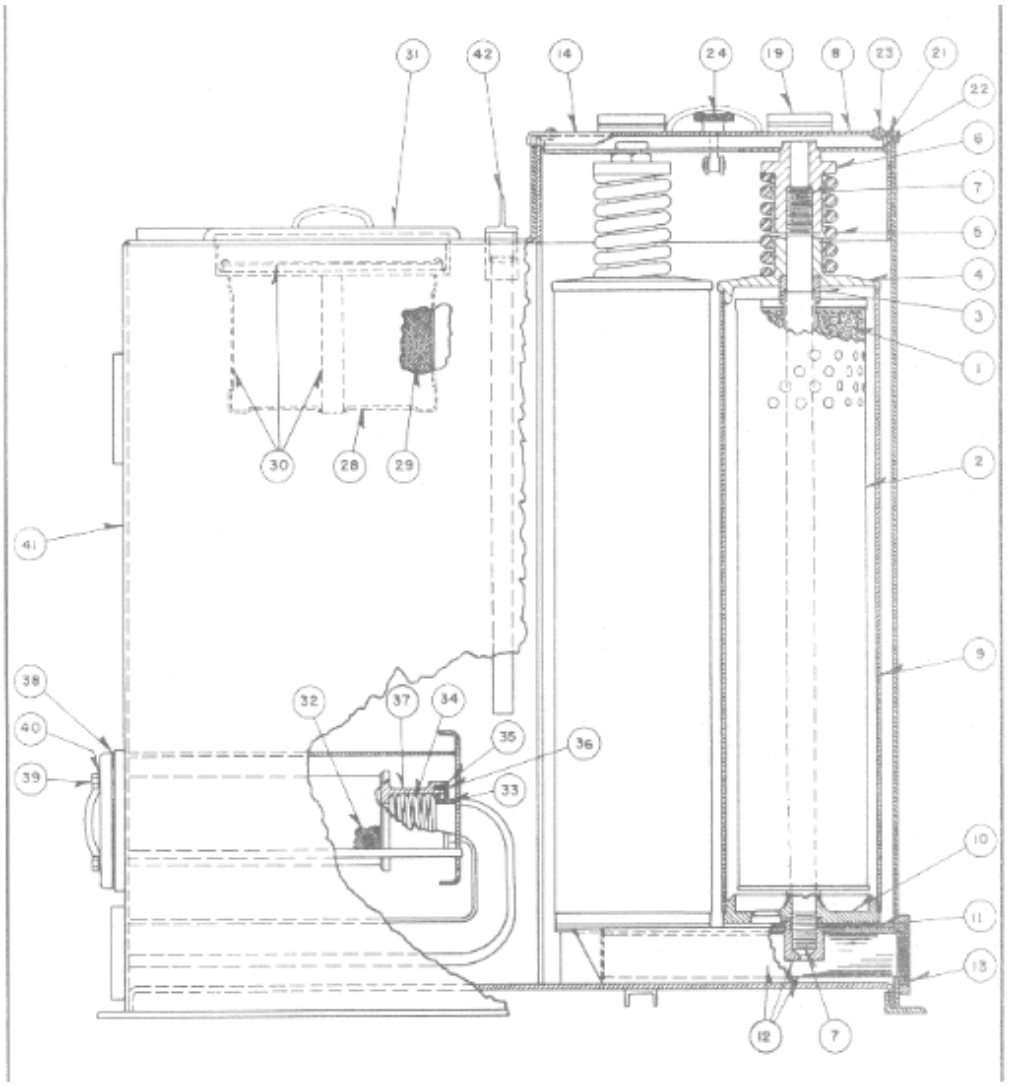
CLEANING TANK SUCTION STRAINERS

Strainers should be removed and cleaned as follows each time the lube oil is changed.

Remove *BOTH* suction strainers from the tank after draining the tank.

Boil the strainers in a steam agitated solution of #10 Oakite for not longer the 10 minutes. The solution should be strong enough to remove all traces of oil film.

Make sure that all lint, dirt, and other foreign materials are removed, steam clean and strainer, then allow to dry.



LUBE OIL FILTER & TANK
PLATE 2325

SECTION IV

FUEL OIL SYSTEM

FILLING FUEL SYSTEM

Fill the fuel tank from either side. Watch the level gauge to prevent overflowing tank. Be sure no fires are near. The fuel should be filtered through a reliable fuel filter before it enters the tank. For fuel oil specifications, see Bulletin 150. Fuel capacity per unit, 1200 gallons.

DRAINING FUEL TANK

The fuel tank has a drain plug in the sump. Every week the plug should be loosened to flush out any sediment or water. The large tank plug is equipped with a small plug through which a diagonal hole is drilled for the purpose of draining off sludge. The small plug is provided with a cotter pin to prevent its dropping out. Care must be taken not to shear this cotter pin off when the small plug is backed out to uncover the drain hole.

FUEL PRESSURES

The large relief valve located between the fuel pump and the Duplex Nugent filter should be set at 60 lbs. The function of this valve is to act as a safety valve to prevent excess pressure from building up in the fuel system. AS the filter bags become clogged with dirt, this excess pressure is liable to cause the bags to tear; also in the case the fuel line becomes restricted at some point, the high pressure that would build up might damage the fuel pump motor or some other parts of the fuel system.

With this relief valve set at 60 lbs., injectors are supplied with an ample amount of fuel oil which acts as a cooling agent.

The small relief valve located at the left front corner of the engine should be set at 5 lbs. with the engine at full load. Its function is to maintain a small pressure head on the injectors, thus insuring complete filling of the injector bodies with fuel. Experience has shown that the injectors operate more satisfactorily with a head on them then without.

Both valves are adjusted by removing the top housing cap and using a wrench to tighten or loosen the adjusting screw and locknut found under the cap. Tightening the screw will raise the pressure at which the valve operates.

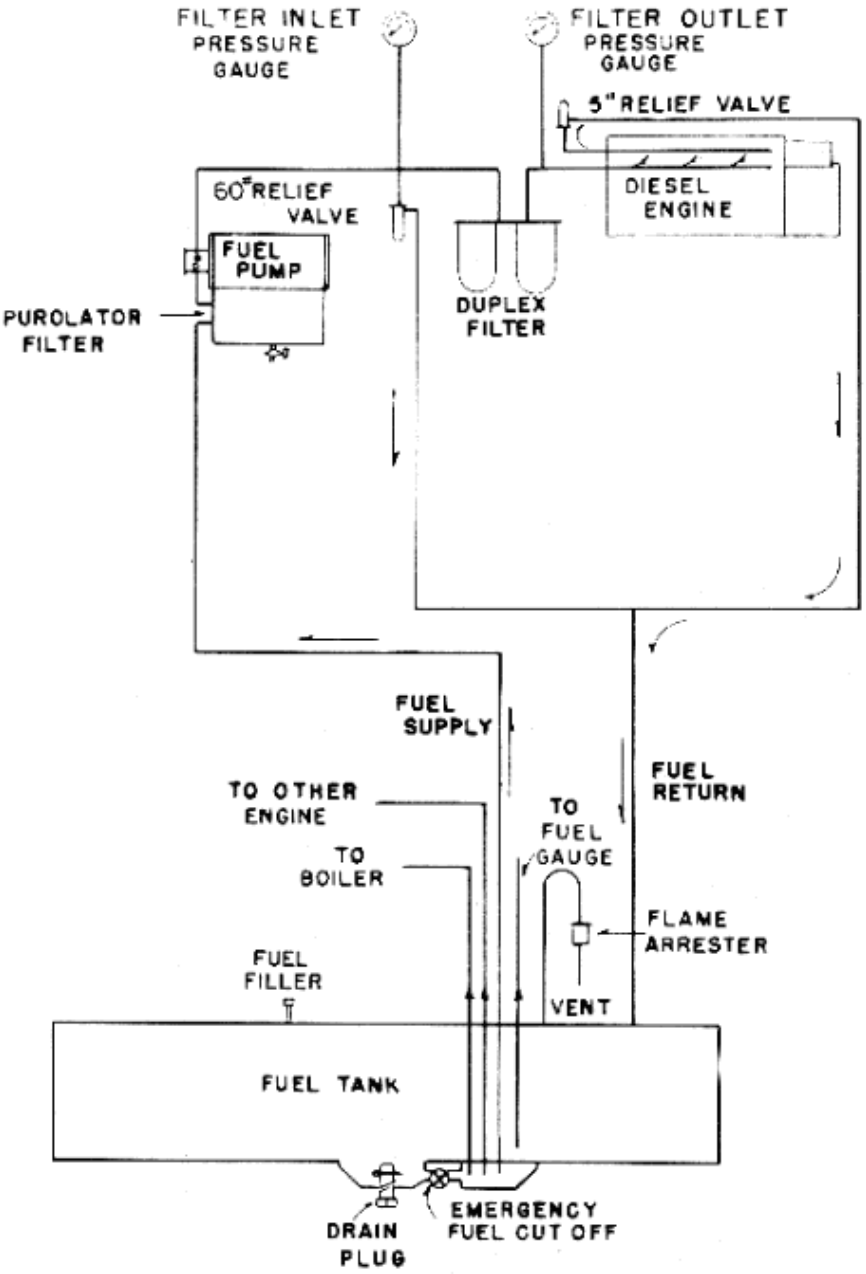
Assuming that both fuel pressure gauges are properly calibrated: Normally the filter inlet gauge will register between 20-30 lbs. of pressure. More than 30 lbs. indicates that the Nugent filter or engine filters are beginning to clog up, or that there is some partial restriction in the fuel line. If the pressure builds up to 60 lbs. the large relief valve will open causing part, if not all, of fuel oil to be by-passed to the fuel tank. This will cause the engine to be starved for fuel. It is intended that only one-half of the Duplex filter be used at a time so the first step to take to reduce the excess pressure is to throw the valve handle on the front of the filter, so that the clean half of the filter is brought into use. If both halves are dirty, it is then necessary to shut down the engine and clean the filter bags.

If this procedure fails to lower the pressure, the fuel line from the Nugent filter to the engine should be examined for a restriction of some kind. The fuel line can be broken at two convenient points and air pressure applied to remove any foreign matter that might be clogging the line. Also check the engine filters (finger strainers and injector filters).

In the event the pressure goes much over 60 lbs. it is an indication that either the relief valve is set too high or that something within the valve is preventing it from opening as it should. An abnormally low pressure on the filter inlet gauge usually means that the Purolator filter is becoming clogged and that the pump is being starved. If cleaning the Purolator doesn't help, then look for something wrong with the pump or its suction line. Low pressure might also mean that the valve is set too low, or that it is not seating properly, thus by-passing fuel before normal pressure is built up.

The fuel filter outlet pressure gauge is used as a check on the condition of the filter bags in the Duplex Nugent filter. The difference in pressure between the fuel filter inlet pressure gauge and the outlet pressure gauge is the "drop" across the filter. This should never exceed 20 pounds and it is best to turn the filter handle (or renew the bags if no clean bag is left) when the "drop" reaches 15 pounds.

If the relief valves are removed and disassembled, they should recalibrated before using again.



FUEL PIPING DIAGRAM
PLATE 2314

NUGENT FILTER

The Nugent filter, fuel pump, and purolator are located in the group under the engine instrument panel. The Nugent filer which contains bags through which the fuel is filtered, has a handle which may be thrown in any one of three positions: horizontally to the right, which directs the entire flow through the left hand bag; horizontally to the left, which directs the entire flow through the right hand bag; or vertically downward, which causes the flow to be divided equally between the two bags. It is recommended that only one bag be used during the operation, the other bag being kept clean. Thus, if the inlet fuel pressure builds up and the engine becomes starved due to a dirty filter bag, the filter handle must be turned to switch the flow of fuel through the other bag. If the handle is switched over during operations, the maintainer should be notified so that he can clean the bag. See Bulletin 804 for maintenance of filter.

BOILER FUEL SUPPLY

The boiler receives its fuel from the main fuel tank, used by the engine.

The boiler has its own fuel pump, filter, relief valve, and pressure gauge.

EMERGENCY FUEL CUT-OFF

In the event of fire or inability to stop the engine in the usual way, an emergency fuel cut-off valve is provided to cut off fuel supply to the engine.

This valve is located between the supply sump of the fuel tank and the suction pipe to the fuel pump. On either side of the locomotive, attached to the underframe, is a small box with a lift cover enclosing a pull ring on the end of a cable running to the shut-off valve. Also, one of these rings is located in the cab. The valve is closed and fuel shut off by pulling any one of these three rings.

In the event that one of these rings has been pulled out, the valve at the front end of the fuel tank must be reset by hand to the "open" position. Check the operation of the emergency fuel cut-off every 10,000 miles.

RUNNING FUEL PUMP

(See Bulletin 802 for maintenance of Fuel Pump.)

In starting the power plant, let the pump run only long enough to build up the desired pressure in the crossflow line. The pump should not be left running unnecessarily. Although the oil will pass through the crossflow system, there is a possibility that the fuel oil might get into the lubricating oil causing dilution if there was a leak in the fuel system.

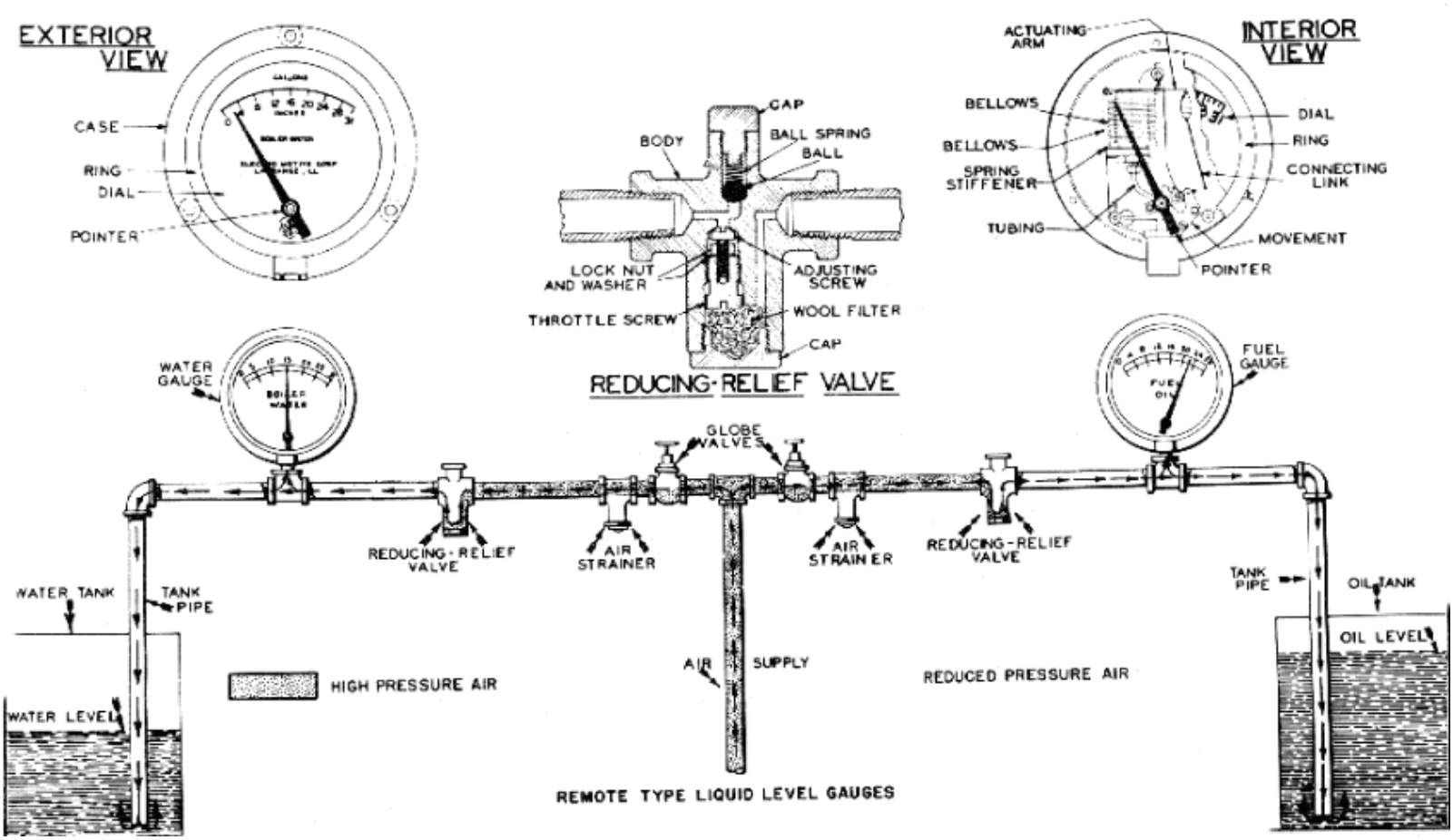
FUEL FAILURE

If the fuel pump motor is running, but the pump is not delivering fuel to the injectors, check the following:

- 1. Supply of fuel in the tank.
- 2. Emergency fuel cut-off valve.
- 3. Broken motor or pump shaft, or loose flexible coupling.
- 4. Loose supply line.
- 5. Clogged supply line.
- 6. Clogged by-pass relief valve; dirt lodged under the valve seat will prevent fuel oil pressure from building up.
- 7. Defective pump; the pump seals must be in good condition and there must be no scores on either the pump or housing.
- 8. Check purolator gaskets for air leakage. If the electric motor is not running, investigate the following:
    - a. Are the fuel pump switches in and in good condition?
    - b. Are the fuses good?
    - c. Check the main battery switch. If the cab lights go on, the switch is closed.
    - d. Check the connection at the motor.

FUEL LEVEL GAUGES - DIRECT TYPE

On each side of the locomotive is located a direct reading sight level gauge, starting 4 and 1/2" from the top of the tank. These gauges are glass so care must be taken not to hit them with the filler nozzle or wrench.



FUEL LEVEL GAUGES - REMOTE TYPE (SEE PLATE 2321)

The fuel levels are indicated by air operated gauges.

Air at reduced pressure (approximately 2 lbs.) forces the water out of the tank pipe, bubbles out of the end of the tank pipe, and exactly balances the weight of the liquid in the tank. The indicator measures the air pressure necessary to balance the weight of the liquid in the tank, and is calibrated to read the amount of liquid in gallons.

Air from the main reservoir passes through a globe valve, then through an external strainer, and then through the reducing-relief valve. The purpose of the reducing-relief valve is to limit the air flow and reduce the air pressure. The reducing and relief valve has a built-in relief valve to protect the indicator against over-pressure in case the low pressure air line becomes plugged. The reducing-valve also is equipped with an internal strainer to prevent it from plugging. This reducing-relief valve reduces main air reservoir pressure to approximately 2 pounds pressure.

Unscrew cleaning plug at bottom of each air strainer, remove waste and repack tightly with clean dry waste. This should be done every thirty (30) days.

All connections should be *absolutely air tight.* To check for leaks, close globe valve in high pressure air line; if air leaks are present at joints, and globe valve is tight, an immediate dropping of the hand on the gauge will be noted. Another indication of air leaks in the low pressure line is a reduced tank capacity indication when the tank is filled. hen when all air leaks are eliminated, the hand on the indicator will indicate full capacity.

To reset hand on gauge, break a low pressure line connection, and with atmospheric pressure on gauge, set hand at zero graduate on dial. Atmospheric pressure on gauge can also be obtained by removing cap, ball spring, and ball from reducing and relief valve.

If throttle screw threads become plugged with dirt, remove and clean with a solvent.

Renew wool yarn in filter in bottom of reducing relief valve once every sixty (60) days. The correctness of these gauges should be checked every 50,000 miles.

PUROLATOR FILTER

Before the oil enters the supply pump, it passes through the purolator filter which has a .003" spaced wire wound drum. The handle which operates the drum scraper should be turned every hour, while the engine is running. The filter housing should be drained monthly, with the pump shut off.

To clean the element, wash it in a petroleum solvent and blow clean with dry compressed air. Repeat every 25,000 miles.

"FINGER" AND INJECTOR STRAINERS

Under pressure the fuel goes to the supply header running to all cylinder heads. Before the fuel passes through the cylinder head casting, it is filtered for the third time through the finger strainer (.002" mesh). Just as the fuel enters the injector, it is filtered for the fourth time (sintered bronze). The purpose of all this filtering is to protect the injector. Every precaution must be taken to protect this finely machined, yet very rugged, piece of equipment from getting any dirt inside. See Bulletin 150 for details of cleaning the engine filters.

INJECTOR

For details of this unit, see Bulletin 150.

FUEL TANK VENTS

Two vents, one on each side, with 4" flame arresters terminate outside the locomotive.

SECTION V

ELECTRICAL SYSTEM

TRANSITION

This definition is inserted at this point so that the reader who is unfamiliar with this term will not be confused by its use in later pages.

This term applies to the changing of the traction motors electrical connections from series to parallel or to shunt. This is done to obtain the desired tractive effort and speed within the voltage operating limit of the generator.

To obtain the maximum tractive effort from the motors when the train is at low speed, they are connected in series. (See Plate 2289 Fig. 1). As the speed increases, the generator voltage increases until the voltage (transition) relay closes, operating the traction motor contactors, connecting the motors in parallel. This reduces the generator voltage.

As the motor speed continuous to increase, the generator voltage increases again closing the transition relay. The relay then operates the shunting contactors which connect resistors across the motor fields, lowering the generator voltage. If the train speed continues to increase the transition relay remains closed.

When train speed decreases, first the transition relay drops out, opening the shunting contactors. Further reduction in speed has no effect on the transition relay so to bring the motors to their original connection (series) the throttle must be brought to idle.

Refer to "Motor Control" Plate for the electrical apparatus involved in transition.

With the control switch in, air pressure up and the engine stopped, check operation of contactors and relays, as throttle is opened and put equipment through transition manually every 10,000 miles.

MOTOR CONTROL CIRCUIT EXPLANATION

Refer to Plate 2289.

FORWARD TRANSITION

Before the locomotive will move, the following switches must be closed; Main Battery Switch, Main Control Switch, Control (Push Button) Switch, Generator Field Switch, and Isolation Switch. The reversing handle and Reverser must be in "Forward" or "Reverse". The throttle must be in No. 1 position to complete the circuit to the control equipment. The Pneumatic Control Switch must be set.

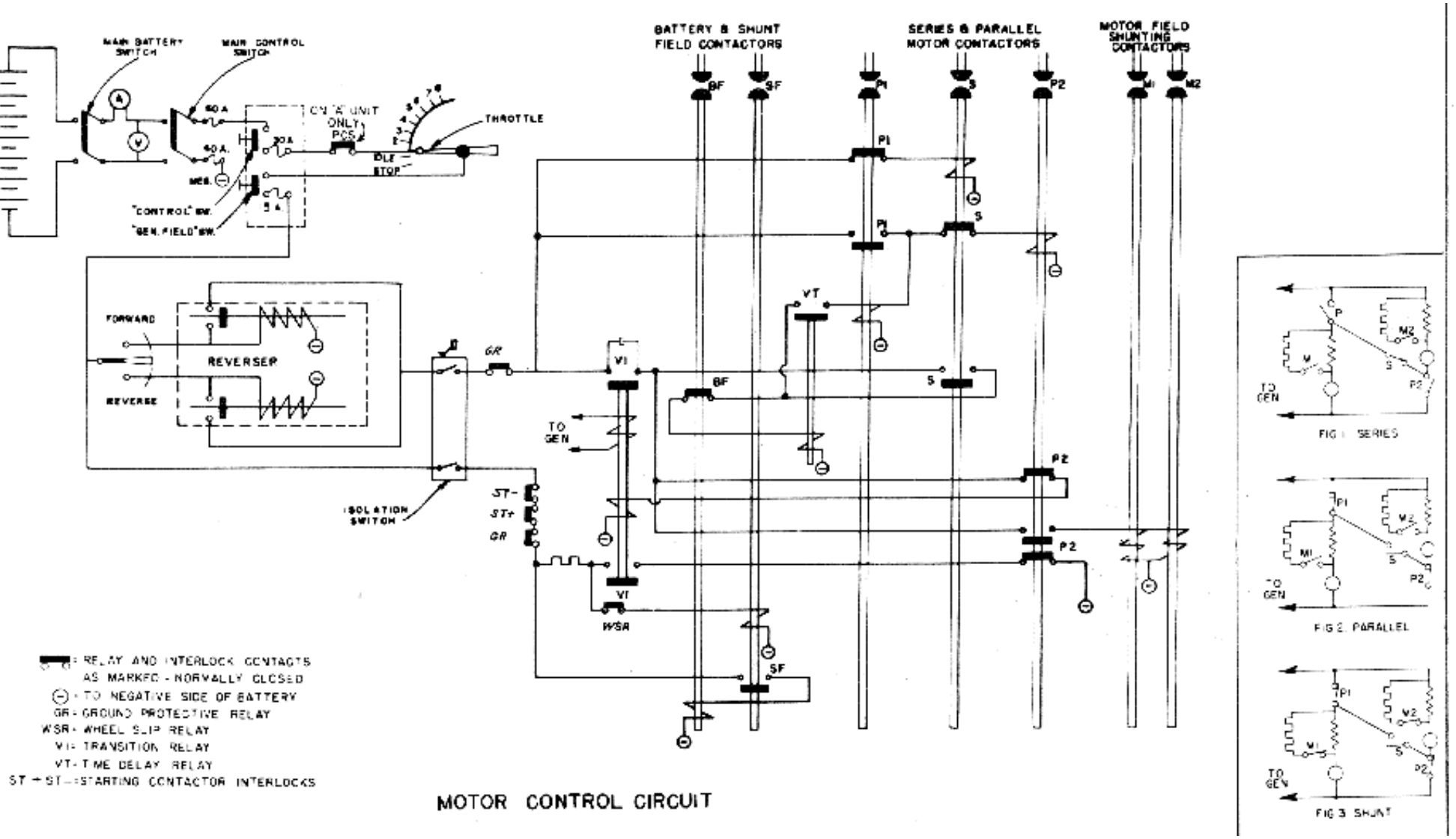
- 1. Idle to Series Transition (Starting the Locomotive).
  - a. Open throttle completes electrical circuit to relays and contactors.
  - b. S contactor closes through P1 Interlock.

- c. SF contactor closes through st-, ST+, GR and WSR.
- d. BF Contactor closes through SF Interlock.

- 2. Series to parallel transition (34 MPH approximately).
  - a. Transition Relay picks up.
  - b. Holding coil is energized through V1 and P2 Interlocks.
  - c. V1 closing drops SF and BF contactors. (This reduces engine speed to 7th position).
  - d. V1 Operating Coil is thereby de-energized.
  - e. Time Delay Relay closes through V1, S, and BF Interlocks closing VT.
  - f. P1 Contactor closes through V1, S, and VT.
  - g. P1 Interlock holds P1 contactor closed.
  - h. S contactor is de-energized at P1 Interlock.
  - i. P2 Contactor closes through P1 and S Interlocks.
  - j. V1 Holding Coil is de-energized by P2 Interlock.
  - k. SF and BF contactor close by opening V1 Interlock. (Engine speed returns to 8th position).
  - l. VT Relay is de-energized by BF Interlock opening.
- 3. Parallel to Shunt Transition (over 80 MPH) approximately).
  - a. Transition Relay picks up.
  - b. M1 and M2 Contactors close through V1 and P2 Interlocks.

BACKWARD TRANSITION

- 1. Shunt to Parallel Transition (80 to 34 MPH approximately).
  - a. Transition Relay drops out.
  - b. M1 and M2 Contactors open.
- 2. Parallel to Series Transition (Only accomplished by closing throttle to idle).
  - a. Throttle circuit opens, de-energizing P1, P2, BF, and SF Contactors.



MOTOR CONTROL CIRCUIT
PLATE 2289

December 1940

MAIN GENERATOR

This supplies the electrical energy used to move the locomotive. See Bulletin 422 for maintenance.

AUXILIARY GENERATOR

This charges the battery. With the battery charging, the current operating all low voltage electrical equipment in the locomotive is actually coming from the auxiliary generator. See Bulletin 421 for maintenance.

TRACTION MOTORS

These supply all the power used to move the locomotive. See Bulletin 1119 for maintenance. There are two motors per truck. For each power plant (diesel engine generator) there are two traction motors. They operate independently of each other traction motors on the locomotive. See Bulletin 1118 for method of removing pinions. Every 10,000 miles blow out the traction motors with clean dry air and inspect the brushes, leads and commutators. Check armature and axle bearing temperature daily.

CONTROLLER

The controller or control station contains the throttle handle, through electric contacts, operates the electro-pneumatic governor control. This is connected mechanically to the engine governor, which in turn controls the speed of the engine. The reverser handle operates electric contacts which allow current to operate either to forward or reverse magnet valves on the reverser in the control cabinet. There is no connection between the reverser handle and the reverser if the electrical circuit is open. See the wiring diagram for details. The throttle lever and reversing handle are inter-connected through a mechanical interlocking making it impossible;

- 1. To move the throttle lever unless the reversing handle is properly inserted in the Control Station.
- 2. To remove the Reversing Handle unless the Throttle Lever is in the "idle" position.
- 3. To move the Reversing Handle from one position to another unless the throttle is in "idle" position.

REVERSER

This air operated reversing switch changes the direction of flow of the current through the traction motor field, thus causing the motors to rotate, in the opposite direction. The current never reverse in the generator. If the air pressure is low (should be 80 plus or minus 3#) or either of the magnet valves on top of the reverser are inoperative, the reverser will not operate properly. See Bulletin 1316 for maintenance. Every 100,000 miles check the operation of the air motors and renew any worn piston leathers or seals.

FUEL PUMP MOTORS

These 1/4 HP motors drive the fuel pumps. See Bulletin 806 for maintenance. Each diesel engine has one fuel pump motor driving one fuel pump. The motors are equipped with double shielded bearings.

HEADLIGHT DYNAMOTOR

See Bulletin 423 for maintenance. The dynamotor converts the battery voltage to approximately 12 volts to operate the headlight. It is located in the hood. For exact output voltages see paragraph on "headlight resistor".

ENGINE STARTING CONTACTORS

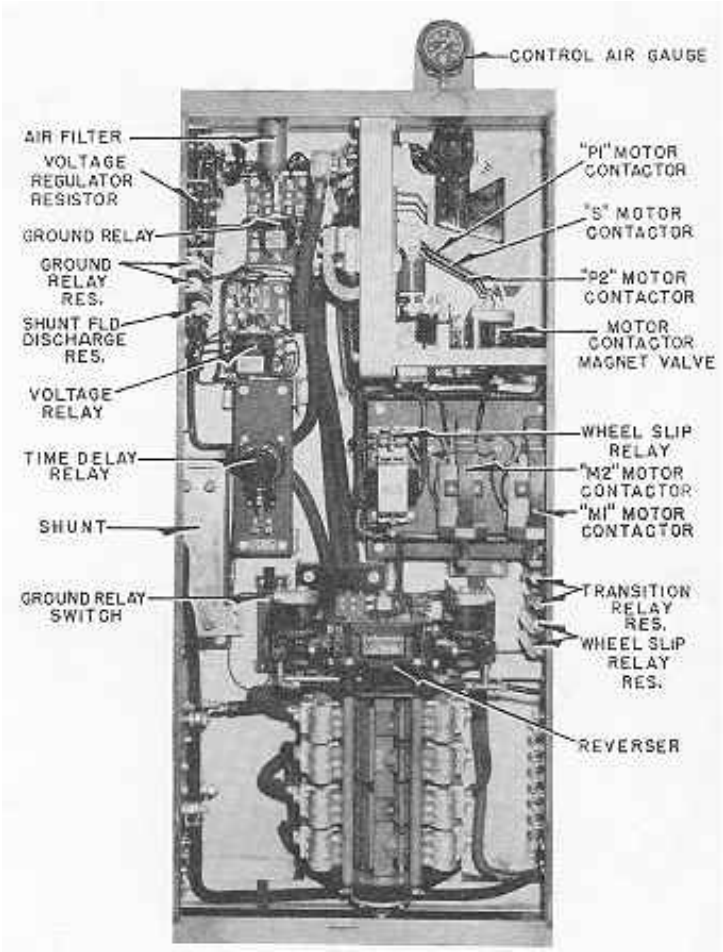
See Bulletin 562 for maintenance. These contactors close when the engine start switch is closed, connecting the battery to the main generator, causing it to become a motor to crank the diesel engine. Interlocks on the contactors open the generator field circuit when the contactors are operating.

BATTERY CHARGING CONTACTOR

See Bulletin 565 for maintenance. This contactor operated by the reverse current relay, closes to connect the battery to the auxiliary generator when its voltage is high enough to charge the battery.

BATTERY FIELD CONTACTOR

See Bulletin 564 for maintenance. This contactor connects the battery to the main generator battery field. During transition this contactor is opened reducing the generator output.



HIGH VOLTAGE CABINET

PLATE 2320

January 1941

GENERATOR SHUNT FIELD CONTACTOR

see Bulletin 566 for maintenance. This contactor connects the generator shunt field to the generator armature. This contactor is opened during transition, reducing the generator output.

TRACTION MOTOR FIELD SHUNTING CONTACTOR

See Bulletin 562 for maintenance. These contactors are known as "M1" and "M2" (See Plate 2320). They connect the motor field shunting resistors across the traction motor fields, decreasing the resistance of the circuit. Thus, more current can flow through the armatures, increasing the torque of the motors, which in turn increases the speed of the locomotive.

FUEL PUMP CONTACTOR

See Bulletin 577 for maintenance. When more than one unit is coupled together, this contactor provides a means of taking the current from the battery in the unit where the fuel pump motors are located, thus preventing overload to the leading unit's battery. The contactors are located in the engine instrument panel. This contactor is shown on Plate 2329.

LOAD REGULATOR AND PILOT VALVE OPERATION

See Bulletin 615 for operation and maintenance of load regulator.

See Bulletin 150 for adjustment of the pilot valve linkage.

VOLTAGE (TRANSITION) RELAY

See previous definition of transition. See Bulletin 567 for maintenance. This relay operates the series, parallel, and shunt contactors of the traction motors. As the locomotive starts to move (the motors in series) the generator voltage increases to approximately 980. At this voltage the relay "picks up" to put the motors in parallel. (This occurs at approximately 34 MPH). As the locomotive continues increasing speed and the voltage builds up to 980, the relay operates (approximately 80 MPH), shunting the motor fields. This drops the generator voltage again. If the locomotive continues increasing in speed the relay stays closed.

On the "downward" transition, as the speed decreases the relay "drops out", (700 710 volts) returning the motors to parallel (opening the shunting contactors). After a further decrease in speed, to bring the motors to their original or starting position (series), the throttle must be brought to idle position.

REVERSE CURRENT RELAY

See Bulletin 569 for maintenance. This relay prevents the battery current from "motoring" the auxiliary generator by opening the battery charging contactor when the auxiliary generator voltage drops below the battery voltage.

VOLTAGE REGULATOR

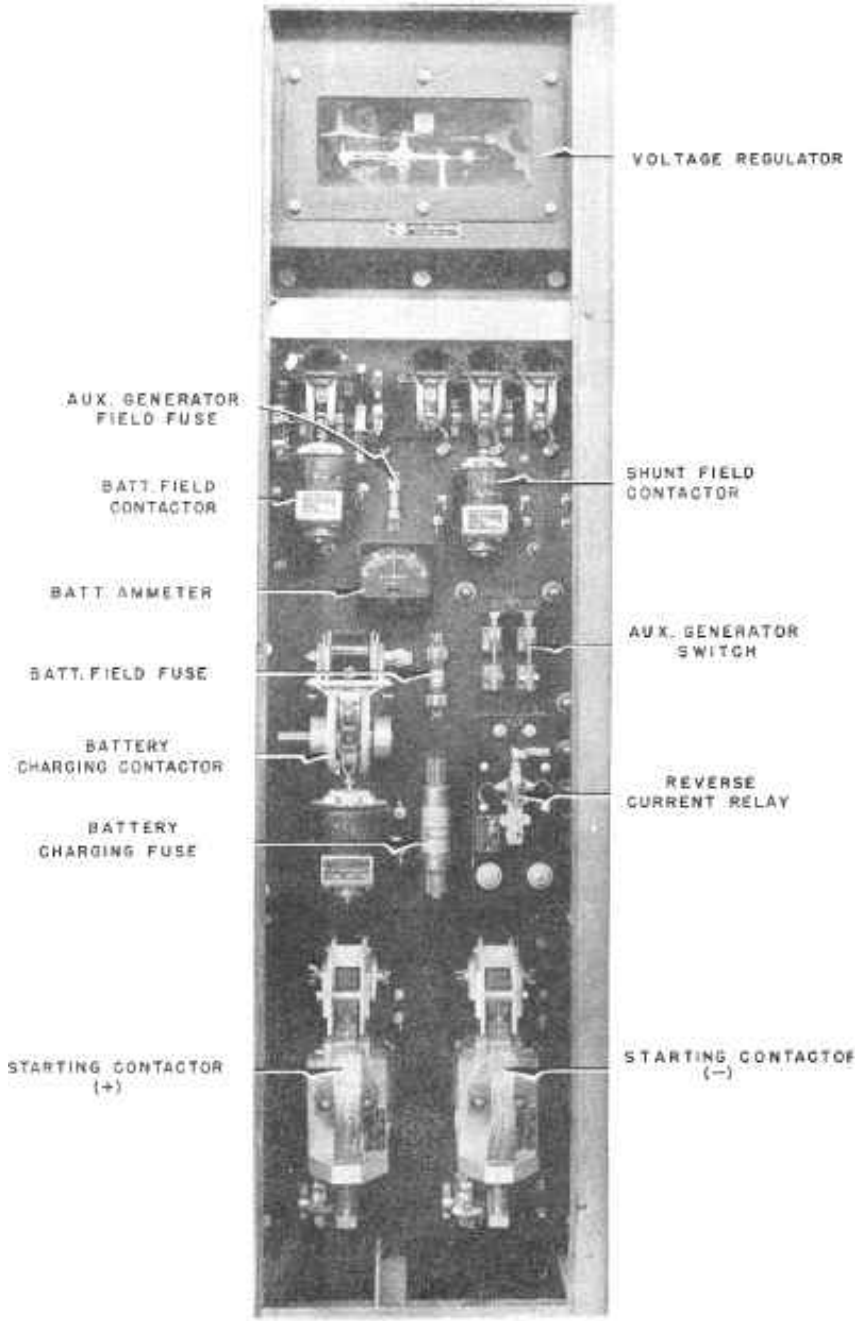
See Bulletin 570 for maintenance. This maintains the output of the auxiliary generators at a constant voltage regardless of the speed of the engine or the gravity of the battery. This keeps the battery charged and provides a constant source of excitation for the main generator. Check the operation and setting of the voltage regulator every 10,000 miles.

GROUND PROTECTIVE RELAY

See Bulletin 562 for maintenance. If a ground occurs in the high voltage system the relay opens the battery and shunt fields. Bring the engine to idle and reset the relay by pushing in on the insulated button provided for emergency. IF the relay repeatedly opens when the engine speed is increasing, the relay can be made inoperative by opening the knife switch located on the High Voltage Panel. Call an electrician and do not run the locomotive unless absolutely necessary. Every 10,000 miles check the high and low voltage system for grounds.

WHEEL SLIP RELAY

See Bulletin 2012 for maintenance. It operates when a wheel slips because one of its two solenoids (which are normally opposed magnetically and balanced) increases it pull on the contact armature. When it operates, it flashes the wheel slip light, prevents the traction motors from going into parallel and opens the generator field contactors. When this occurs, it is necessary to throttle down until the wheel stop slipping and then reapply the load by opening the throttle more gradually. If necessary to use sand, it should be applied (sparingly) only after the wheel stop slipping. The relay operates only when the motors are in series. Due to the fact that "p1" closes slightly before "P2", the relay will pick up causing a brief flash of the wheel slip light. This is an indication of transition from series to parallel. With several power plants going through transition the wheel slip light may flash several times.



LOW VOLTAGE CABINET
PLATE 2322, Rev A

February 1941

OIL PRESSURE RELAY

This relay operates from the low oil switches mounted in the engine oil pumps. It lights the low oil signal and opens the circuit to the master "E" valve. This in turn cuts off the air supply to the "A", "B" and "C" valves in the governor control thus bringing the engine to idle. IF the throttle were in #5 or #6 position the "D" valve should be left energized thus stopping the engine. See Bulletin 572 for maintenance.

JOURNAL SIGNAL RELAY

This relay is normally energized. If a journal thermocouple opens, the relay rings a bell and lights the hot journal light. The only way to stop the bell ringing is to remedy the cause of the hot journal or block open the bell contacts at the relay, which is located in the box with the hot journal light. The relay has two contacts which are closed when the operating coil is not energized. The total armature travel at the contact end is 3/16". Unless a tension spring breaks, the relay requires no maintenance. Adjust the spring contact tension so that 10-13 oz. pull is required at the contact end of the armature to bring the armature in contact with the coil core. If the contact become pitted, dress the with a fine file. No individual service bulletin is published on this relay.

SIGNAL RELAY

This relay operates with the signal lights (Boiler out, Hot engine, and Low Oil) to ring the alarm bell. The relay coil operates in parallel with a 6.0 ohm resistor as soon as the relay closes. (see Plate 2201). This allows enough current to flow through the circuit to light the alarm lights. With the relay closed the operating coil is energized by the drop in voltage across the resistor. Therefore, the relay armature must be very sensitively balanced. In replacing the adjusting the tension spring, remove the relay assembly and adjust the tension so that the contacts close with the relay in a horizontal position and open with the relay in a vertical position. If the contacts become pitted, dress them with a fine file. No individual instruction bulletins is published on this relay. Every 10,000 miles check the operation of all alarm circuits.

BOILER RELAYS

All equipment connected with the boiler is covered in the manufacturer's instruction book. See Section II.

TIME DELAY RELAY

See Bulletin 574 for maintenance. This relay delays the closing of "P1" contactor when transition occurs, giving the generator voltage time to drop, thus prevent the arcing of contacts.

POWER SWITCHES "P1", "P2", and "S" (UNIT SWITCHES)

See Bulletin 573 for maintenance. These switches (contactors) change the traction motor connections from series to parallel or vice versa. See the paragraph on transition. These switches operate on air pressure (should be 80-85#) through magnet valves. Be sure the arc shutes are securely in place at all times.

ISOLATION SWITCH

Maintenance on this switch consists essentially in keeping the unit clean. The accumulated dust should be blown or wiped out occasionally. In case the contacts become roughened or pitted, the rough spots should be smoothed off with a fine grade emery cloth. A small amount of petroleum jelly used as a lubricant on the

contact segments will also reduce wear on same. Care should be exercised, however, not to use an excess amount as it will serve as a dust collector. No individual instruction bulletin is published on this piece of equipment. See the wiring diagrams for the electrical connections to this switch.

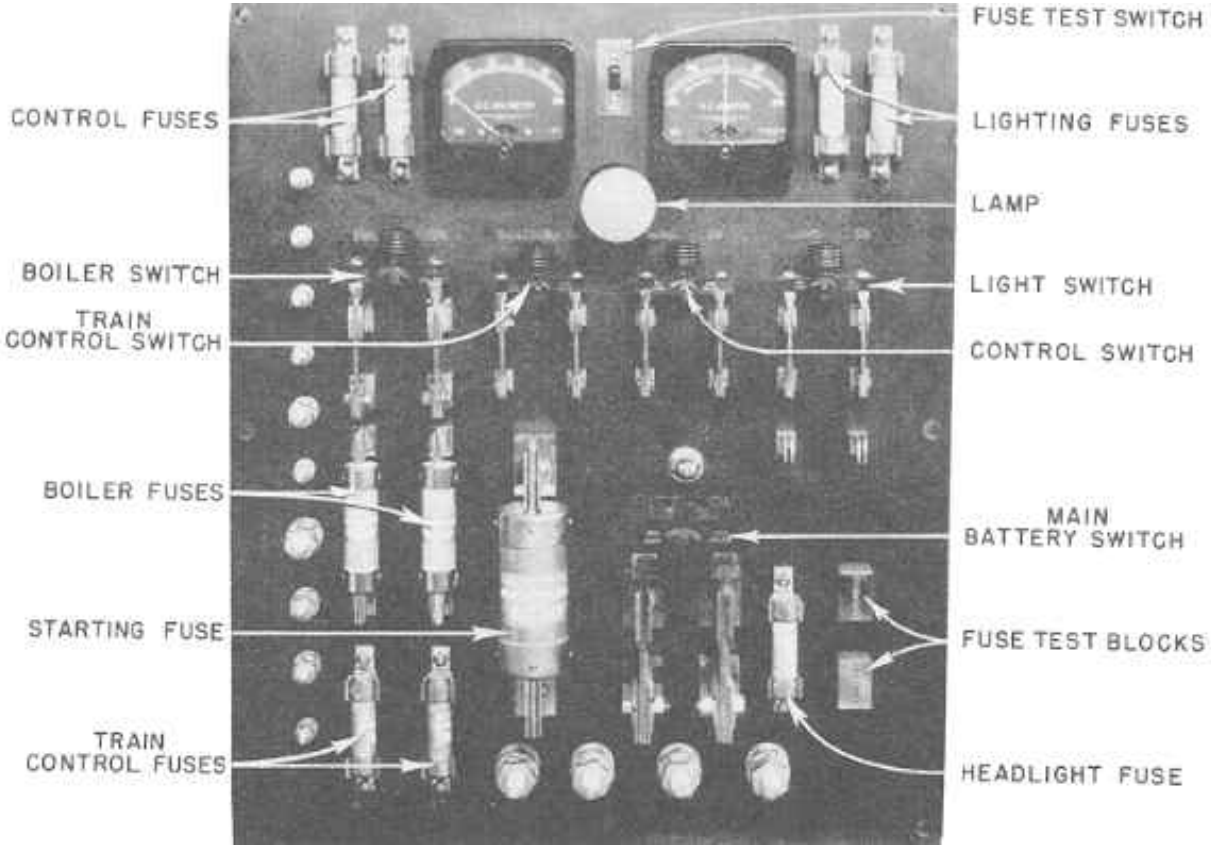
LIGHTING AND CONTROL SWITCHES

See Bulletin 1522 for maintenance. These are the push button switches. The box on the left of the control stand contains the following circuits:

- Headlight Bright
- Headlight Dim
- Number Lights
- Gauge Lights
- Class Lights

The switch on the right of the control stand contains the following circuits:

- Control
- Generator Field
- Fuel Pump
- Attendant Call
- Defroster



DISTRIBUTION PANEL
PLATE 2319

March 1941

LOW OIL SWITCH

See Section III.

MAIN BATTERY SWITCH

This isolates all circuits from the battery except the external charging receptacle. Keep the blades lubricated with a thin film of vaseline so the switch can be operated easily. Opening the switch when an engine is running will not necessary stop the engine. Open the switch when leaving the locomotive or doing maintenance work.

ENGINE TEMPERATURE SWITCH

This is a thermal switch located above the engine instrument panel and connects to 2 thermal elements -- one in each water outlet manifold of the engine. If the eater

temperature exceeds 200 degs F., this switch closes operating the signal relay, which lights the hot engine alarm light and rings the alarm bell. The switch is set to open at 190 degs F. and close at 200 deg F. The tube leading from the elements to the switch must not be kicked or dented.

GROUND RELAY SWITCH

This opens the circuit to the operating coil of the ground relay. (See Plate 2320). See paragraph on Ground Relay in this section.

HEADLIGHT CHANGE OVER SWITCH

This switch is located along the left side of the hood. The standard headlight operates either on the battery or on the dynamotor. Use the dynamotor unless it is inoperative. The "up" position is dynamotor. When connected to the battery, the headlight has no "dim" position.

START AND STOP SWITCHES

These switches will operate only when the isolation switch is in "start" position. The "start" switch operates the starting contactors. The "stop" switch energizes the "D" magnet valve in the governor control, causing the engine to stop, (only if air pressure is up). The engine can be started with no air pressure but if it becomes necessary to stop it before pressure has been pumped up, the governor barring down tool must be used (See Bulletin 150 for photograph and description).

CHARGING SWITCHES

One charging switch is used for each power plant. All battery charging equipment of one power plant (auxiliary generator, reverse current relay, battery charging contactor and voltage regulator) is isolated from the battery if one of these switches is opened. This should be done only when some piece of charging equipment fails.

BOILER SWITCHES

One boiler switch is located on the distribution panel. In addition to this master switch the boiler has a main disconnect switch located near the boiler controls.

CONTROL AND A.T.C. KNIFE SWITCHES

Located on the distribution panel, one of these switches controls battery power to the "control" equipment (relays, contactors, etc.) and the other controls the battery power to the Automatic Train Control Equipment.

BATTERY LOAD BALANCING SWITCH

This double pole double throw reversing switch located on the distribution panel balances the load between the two halves of the battery. If more current is consumed in one half the lighting circuit than in the other (due to some lamps burned out or a receptacle being used) reverse the switch once each day.

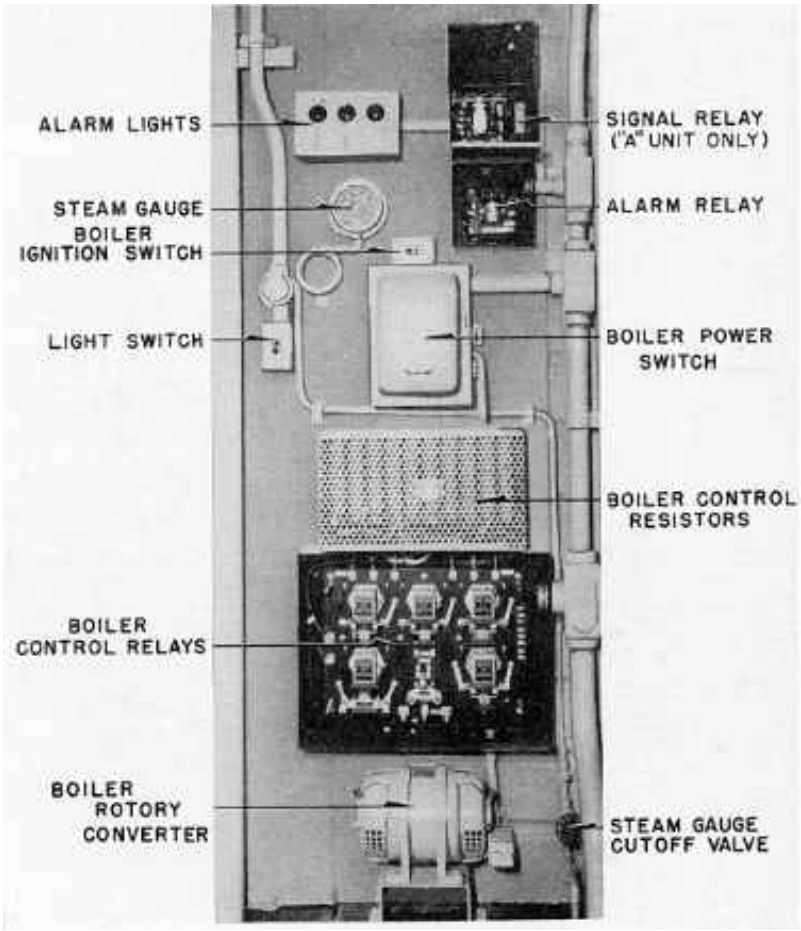
FUEL PUMP SWITCHES

The fuel pump switch on the control stand controls the fuel pump contactors and thus all the fuel pumps. Each fuel pump motor can be shut off by the switch on each

engine instrument panel.

FUSE TEST SWITCH

This switch is in parallel with the fuse test blocks on the distribution panel. A check on the lamp as well as the fuse can be made with this switch. Light the lamp, place a fuse in position on the test blocks, throw the switch "off". If the lamp goes out, the fuse is blown; if it stays lit, the fuse is good. To test a lamp, screw it into the socket and throw the switch "on".



BOILER & ALARM RELAY PANEL
PLATE 2324

January 1941

ENGINE ROOM LIGHT SWITCH

The two switches operate independently of each other to turn off or on the engine room lights. If the lights are on, either switch will turn these off and vice versa.

CAB LIGHT SWITCH

This switch turns on the two hood lights. It is located behind the engineer's seat.

HOOD LIGHT SWITCH

This switch turns on the two hood lights. It is located to the right of the door to the hood.

ORDER LIGHT SWITCH

This switch turns on the order light for the engineer. It is located above and to his right.

PNEUMATIC CONTROL SWITCH

This is the switch located on the right-hand side of the cab, next to the engineer. The purpose of this switch is to reduce the speed of the engines to idling when an Emergency, Deadman Service or Automatic Train Control brake application is made. This switch also breaks the PC control circuit to the motor control contactors and generator field contactors, as well as the engine control circuit.

The switch has normally closed contacts and is set to open at #40 and close at 20# pressure. The switch is connected to the #22 control valve for emergency application and to the "M" application valve for Deadman or Automatic Train Control applications through the brake application valve, in such a way that a shot of air is communicated to the switch and contacts are opened, which reduces the engines to idling speed. Under normal operation, there is zero pressure on the switch and contacts are closed.

The switch has a "lock-out" button which holds the contacts open after the switch is once operated by emergency application, making it necessary to reset the switch before the engines can again be operated above idling speed. See Bulletin 1525 for maintenance. The switch has a manual reset button. Check the operation of the switch every 10,000 miles.

BATTERY

The locomotive storage battery has 32 cells and it rated at 425 Ampere hours (8 hour rating). Gravity should be checked once weekly and should be between 1230 and 1250. Check the water level once weekly. Use only distilled water to fill and keep water level up to 1" above top of plates. *Be careful not to get any of the battery fluid on yourself or the battery.* This is sulphuric acid and is extremely corrosive. To counteract the acid should it splash on the clothing, put a strong solution of baking soda on the area affected. *Do not use water to wash off acid.*

Keep the battery terminals covered with a thin film of petroleum jelly. This is to prevent corrosion from the battery vapors.

Inspect the cells through the filler holes after the engine has been running continually for sometime. Any bubbling should be reported. IF the battery requires more than just a small amount of water, report this to the maintainer. If the battery is being overcharged, it will boil off water, become overheated and even become short-circuited internally.

BATTERY CHARGING RESISTOR

Connected in series with the output of the auxiliary generator. This resistor prevents overload to the auxiliary generator (too high a charging rate). The voltage regulator is not a current regulator, so in the event the battery was discharged or internally short circuited, this resistor prevents a burnout of the auxiliary generator. Periodically blow clean with dry, compressed air.

SHUNT FIELD RESISTOR

These tubes are connected in series with the generator shunt field. They simply limit the shunt field current. No adjustment is necessary.

SHUNT FIELD DISCHARGE RESISTOR

This resistor is connected in series, but not shorted out by the shunt field contactor when in closed position. It prevents burning of the shunt field contactor contacts or damage to the generator due to the high inductive voltage which might otherwise occur if the contactor was opened with the generator running at top speed.

BATTERY FIELD DISCHARGE RESISTOR

This resistor shunts the main generator battery field to prevent high voltage induction when the battery circuit to the field is opened.

WHEEL SLIP RESISTORS

The 2000 ohm resistors are in series with the relay. The adjustable 700 ohm tube balances the inner coil to the outer coil. See Bulletin 2012 for adjustment of relay with this adjustable resistor.

HEADLIGHT RESISTORS

Two tubes (variable resistors) are connected to the standard headlight push button switches to control the speed (output) of the headlight dynamotor. One variable resistor is in series with the headlight when it is connected to the battery. Adjustment of these resistors should be made, using an accurate voltage, with the headlight on to give 12.5 volts bright, and 8 volts dim, from the dynamotor and 12 volts bright from the battery.

LAMP SERIES RESISTOR

In series with the order light, and throttle indicator light, these resistors drop the battery voltage to 32 volts. 32 volt standard lamps are used.

VOLTAGE RELAY RESISTOR

The resistors are in series to drop the voltage across the relay. The adjustable resistor provides a means of setting the voltage at which the relay will operate.

LOAD REGULAR RESISTORS

See Plate 2258 for circuit and purpose of these resistors. Keep the resistors securely mounted and clean. Do not attempt to change the circuit or value of these resistors.

SIGNAL RELAY RESISTOR

See Signal Relay paragraph in the section.

GROUND PROTECTIVE RELAY RESISTORS

These resistors form a bridge across the main generator so that in the event any point in the high voltage system becomes grounded the ground protective relay will operate.

MOTOR FIELD SHUNTING RESISTOR

This resistor is connected across the traction motor field when the shunt contactor closes. (This is at highest speed transition). Thus more current is allowed to flow through the traction motor armatures increasing the speed of the locomotive. Periodically blow clean with dry compressed air.

HIGH AND LOW VOLTAGE CABINET

The high voltage cabinet houses the high voltage electrical control equipment. (See Plate 2320). *Never work on the equipment in this cabinet with the engines running. Keep doors closed.*

The low voltage cabinet is located on the rear end of the high voltage cabinet and houses the low voltage equipment. (See Plate 2322). Blow out these cabinets every 10,000 miles with dry compressed air. At the same time check all equipment for loose wires or burned contacts.

DISTRIBUTION PANEL

This panel is located behind the engineer's seat in the cab of the "A" unit, and between the #1 Air Compressor and Tractor Motor Blower in the "B" unit. It contains switches which control main circuits throughout the locomotive. (See Plate 2318).

SPEEDOMETER

The speedometer consists of three units; the generator (mounted on the axle), the indicator (on the engineer's instrument panel), and a resistance box, (located in the hood on the right hand side near partition) which can be adjusted to compensate for wheel wear. The only servicing which can be done in the field is to lubricate the generator (See Lubrication Section). Return the three units (*keep them in matched sets)* to be recalibrated and cleaned every three years, or when necessary. See Bulletin 1502 for maintenance.

AMMETER AND VOLTMETER

The voltmeter and ammeter on the distribution panel show the function of the auxiliary generator. The ammeter on the low voltage panel shows total output of the auxiliary generator. Ammeter on distribution panel shows charge or discharge of battery.

If the voltmeter on distribution panel shows battery voltage, but the ammeter in low voltage cabinet remains at zero, it is an indication that the auxiliary generator 150 amp. charging fuse has burned out. If a 30 amp. fuse blows, the ammeter in the distribution panel will show a discharge and the ammeter in the low voltage cabinet will read zero, (if the other power plant is shut down). These two fuses are in the low voltage cabinet. A defective voltage regulator will be evidenced by excessive fluctuations of the ammeter and voltmeter. Broken or loose "V" belts will affect the charging rate and the excitation of the main generator.

TACHOMETER

The tachometer is electrically operated having a magneto mounted in the engine instrument panel. The magneto bearings are packed with a very special heavy lubricant when the magneto is assembled and should be good for two or three years. At the end of this time at least the magneto and preferably both magneto and indicator should be returned to Electro-Motive Corporation servicing. No attempt should be made to service this equipment in the field. If the indicator hand does not come to zero when the engine is stopped, it can be brought to zero by turning the zero corrector on the outside of the indicator.

BATTERY CHARGING RECEPTACLE

Connected directly across the battery through a 100 amp. fuse is the external charging receptacle. An ammeter in the external charging equipment must be used as a check on the charging rate. The main battery switch can be either open or closed, for with the power plant shut down the reverse current relay opens and the auxiliary generator charging circuit. Do not run the engines with an external charger connected.

GOVERNOR CONTROL MASTER ("E") MAGNET VALVE

The magnet valve controls the air supply to the "A", "B" and "C" valves of the governor control. De-energizing this valve either brings the engine to idle or stop, depending on the position of the "D" valve, as determined by the throttle position. See Bulletin 604 for maintenance.

GOVERNOR CONTROL MAGNET VALVES

See Bulletin 150 for maintenance of the Electro-Pneumatic Governor Control.

The governor control consists of a set of 4 air pistons operated by magnet valves lettered "A", "B", "C", and "D". "A", "B" and "C" are on a common air supply while "D" is independent. The Governor Control master valve "E" controls the air supply to valves "A", "B", and "C". As noted in the chart on plate 2287, the ten positions of the throttle energize various combinations of these magnet valves thud rotating the serrated governor control shaft. The governor then controls the engine speed. During transition the valve "A" is de-energized. This gives the equivalent of a No. 7 throttle position even though the throttle is in No. 8 position.

Every 10,000 miles test the operation of the magnet valves, and every 100,000 miles check the lift of the armatures and clean the valves.

DEFROSTER MOTORS

Two motors in the cab drive blowers for windshield defrosting. These motors are rated at 1/6 HP at 110 volts but develop less power because they operate on the battery voltage. The brushes should be replaced annually. No individual instruction bulletin is published on these motors.

HEADLIGHT

The headlight consists of seven 50 candle power bulbs, each with its own reflector. The accumulated light gives a broad band of visibility both side-ways and vertically. The headlight can be operated either from the headlight dynamotor or from the battery. For voltage setting see paragraph on headlight resistors in this section.

CLASS AND NUMBER LIGHTS

These are located on each side of the hood. Number lights are 15 watt, 32 volt lamps. Class lights are bayonet type 64 volt - 30 watts.

ALARM INDICATOR LIGHTS

Tri-color signals include boiler stopped (green),low oil (yellow), and hot engine (red). The wheel slip alarm light is on the engineer's instrument panel. The hot journal light is on back of the cab partition.

ALARM BELL

The alarm bell operates whenever any of the above alarm indicator lights operate (except wheel slip), and will continue to ring until the condition is remedied.

JUMPER CABLE (16 CONDUCTOR)

This cable carries the following circuits between locomotive units:

NO.	CODE	CIRCUIT	NO	CODE	CIRCUIT
0	RE	Reverse (#2 End)	8	FO	Forward (#2 End)
0	FO	FORWARD (#1 END)	8	RE	Reverse (#1 End)
1	OS	Oil Signal	10	WS	Wheel Slip
2	SG	Signal	11	BA	Boiler Alarm
3	DV	"D" Valve	12	BV	"B" Valve
4	N	Negative	13	PC	Positive Control
5	TS	Temperature Signal	14	SN	Signal Negative
6	GF	Generator Field	15	AV	"A" Valve
7	CV	"C" Valve	16	FP	Fuel Pump

BOILER EQUIPMENT

See Section II.

HOT JOURNAL ALARM THERMOCOUPLES

Refer to Plate 2267.

WHEN ALARM GONG OPERATES

- 1. *Stop train*. Determine which unit is sounding gong. All gongs sound but hot journal indicator lights in defective unit only. Look for hot journal. If journal is hot, examine for cause and correct trouble or, if advisable, proceed with caution.
- 2. If journal is not hot but gong continues to ring, before reaching terminal check for defective relay, fuse, or loose wire. If it is determined that a defective thermocouple is causing the gong to ring, proceed to the terminal and located the thermocouple as outlined in paragraph 4 and 5.
- 3. It may be necessary to silence the gong. If so, open bell cutout switch "A". This will not interfere with hot journal alarm on other unit or other alarms on any unit.
- 4. To determine the truck in which a thermocouple is open, remove rubber jumper from truck to locomotive and insert the short-circuited tester plug (8004923) into the locomotive receptacle "C". If alarm gong stops sounding, proceed to check individual thermocouples as in next paragraph.
- 5. With gong sounding, insert the tester plug into each thermocouple receptacle "D" until the gong stops ringing. Never operate the locomotive with tester plug in receptacle as this prevents the thermocouple on the journal from functioning.

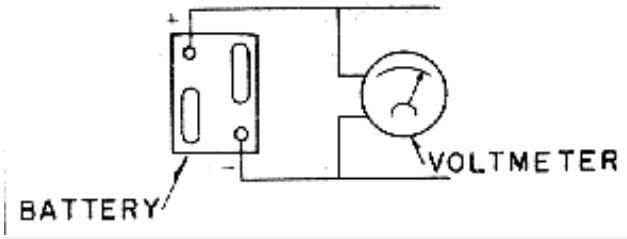
TO TEST THE THERMOCOUPLE TO DETERMINE WHETHER IT IS FUNCTIONING PROPERLY

- 1. Cases my occur where a closed thermocouple is not necessarily a good one. A suitable testing arrangement can be made by heating a container of oil in which is hung a thermometer and the thermocouple.
- 2. Connect the thermocouple in series with a lamp of not more than 10 Watts on 110 Volts and note at what point the lamp goes out as the temperature of the oil rises. All thermocouples are set to open at 230 degs F. A tolerance of minus 5 degs or plus 10 degs is allowed.

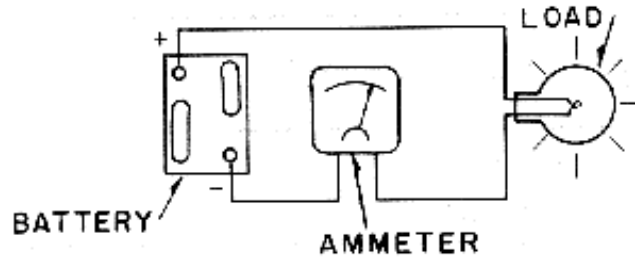
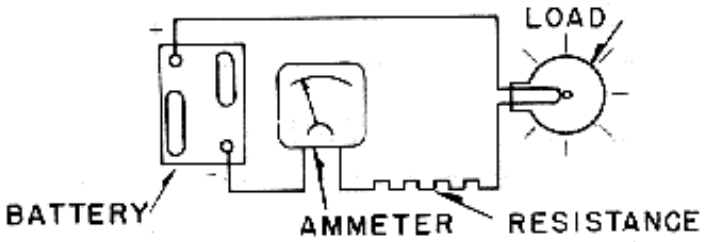
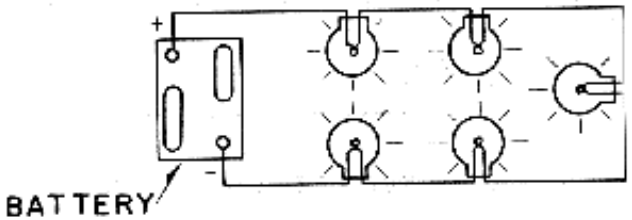
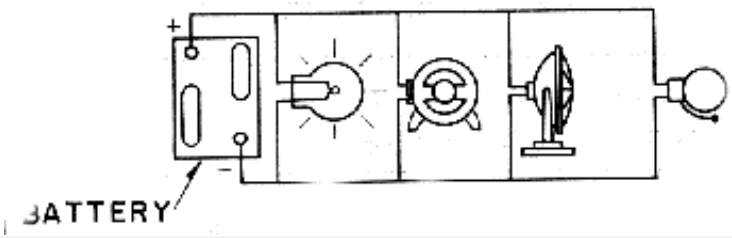
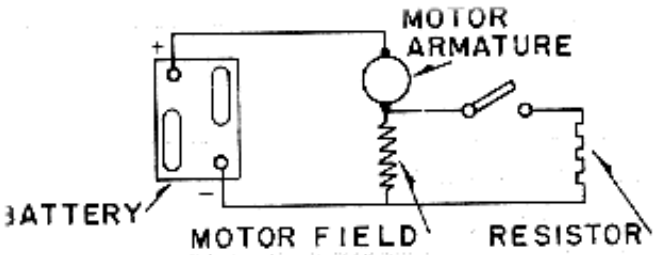
INSULATION DIELECTRIC TESTS

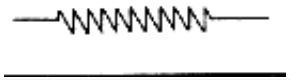
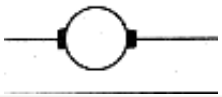
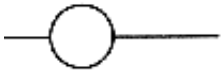
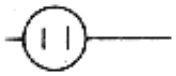
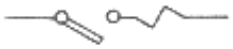
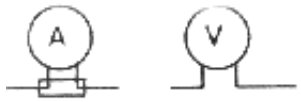
These tests should be run every 100,000 miles as outlined in Bulletin 2100. See Bulletin 1702.5 for electrical testing tools.

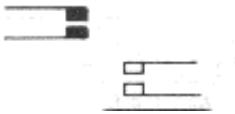
June 1941



A volt is a unit of electrical pressure. The higher the pressure (voltage) of a battery the more current it will force through a wire, coil, lamp, or other device.

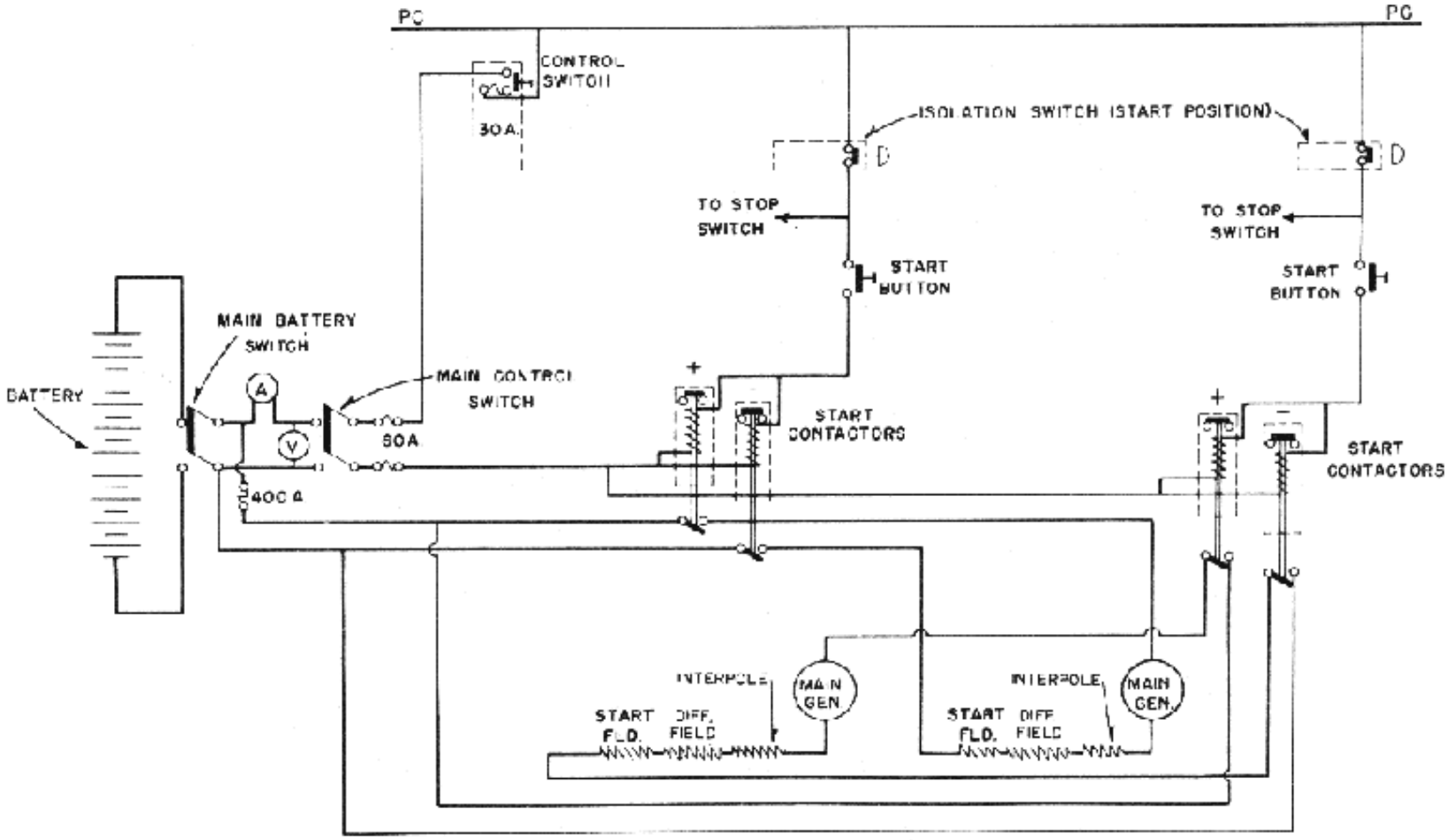
	The ampere is a unit of the amount of current in a circuit. Current flows from a source on one wire and flow back on another.
	Resistance (measured in ohms) is the "holding back" quality of a circuit. A circuit of low resistance will allow a large current to flow and vice versa.
	When objects are connected so that the same current flows through one after the other, they are in series. The current is the same anywhere in the circuit.
	When objects are connected across a source so that the current in each is independent of the other, they are in parallel. The current from the source is the total of the currents flowing through all objects across the line.
	If a device is connected in parallel with some equipment, thus bypassing a portion of the current which would otherwise flow through that equipment, it is in shunt.
	Batter of three cells

	Contactor or relay coil motor or generator field coil
	Motor or generator armature
	Fixed resistor Variable Resistor
	Lamp bulb
	RECEPTACLE or electric outlet
	Push button SWITCH with a spring return
	Snap or toggle SWITCH
	contactor main CONTACT with blowout coil
	Single pole & double pole knife SWITCHES
	Normally open INTERLOCK Normally closed INTERLOCK
	Ammeter with shunt and voltmeter
	FUSE

	Wires not connected Wires connected
	Temperature switch Thermocouple

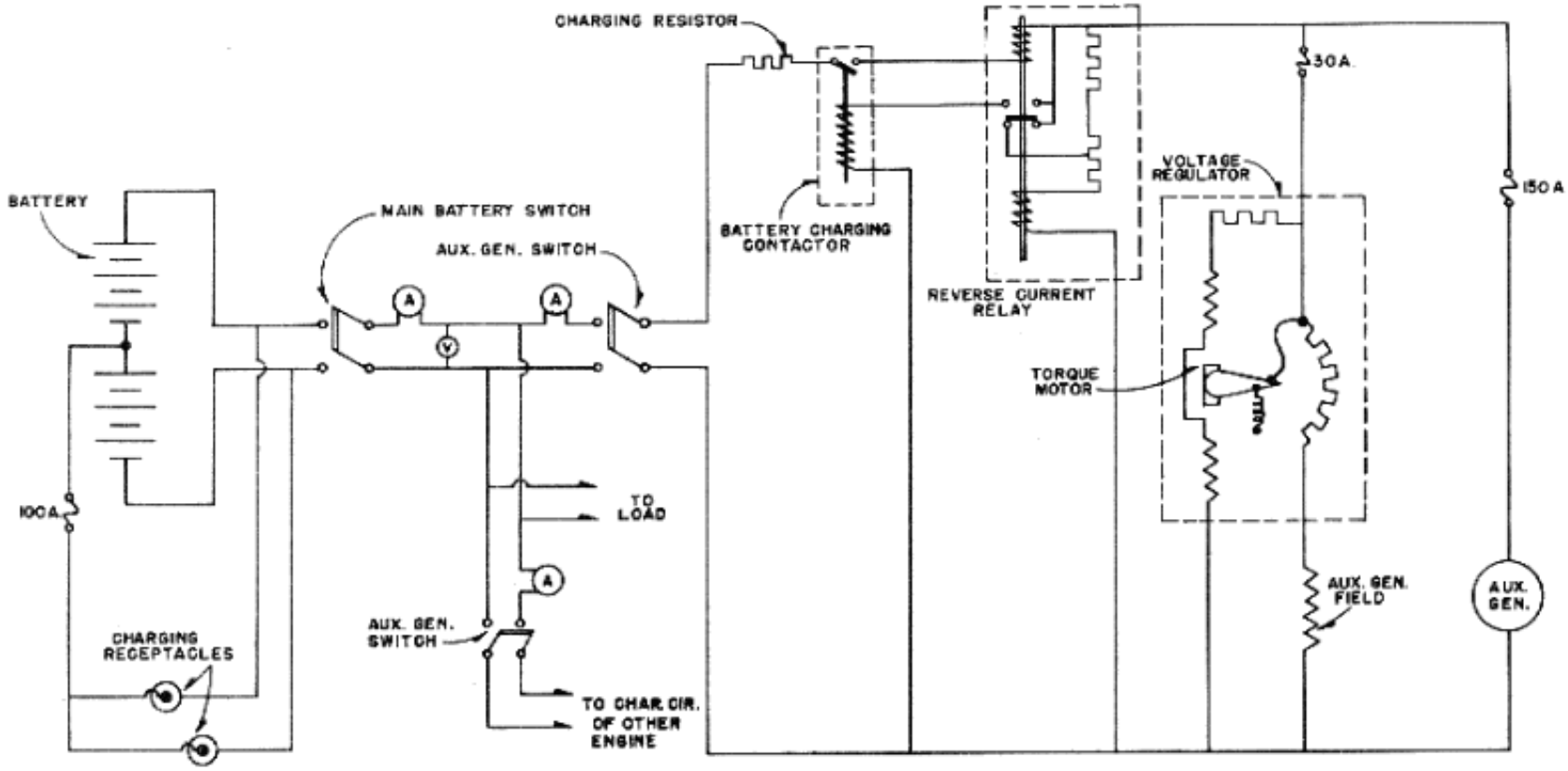
EXPLANATION OF ELEMENTARY ELECTRICAL TERMS
Common Electrical Symbols
PLATE 2323

July 1941



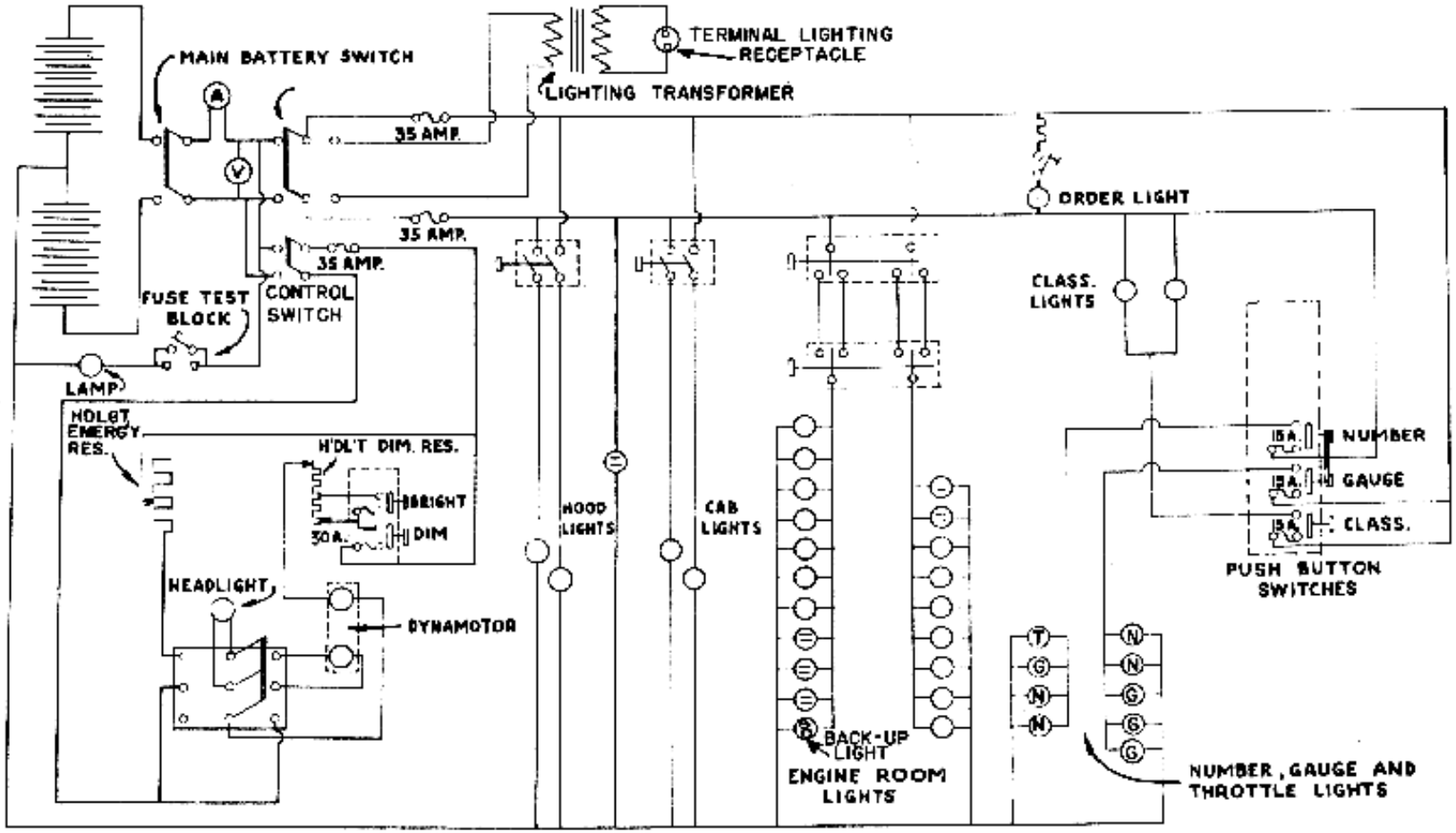
STARTING CIRCUIT
PLATE 2283 Rev A

July 1941



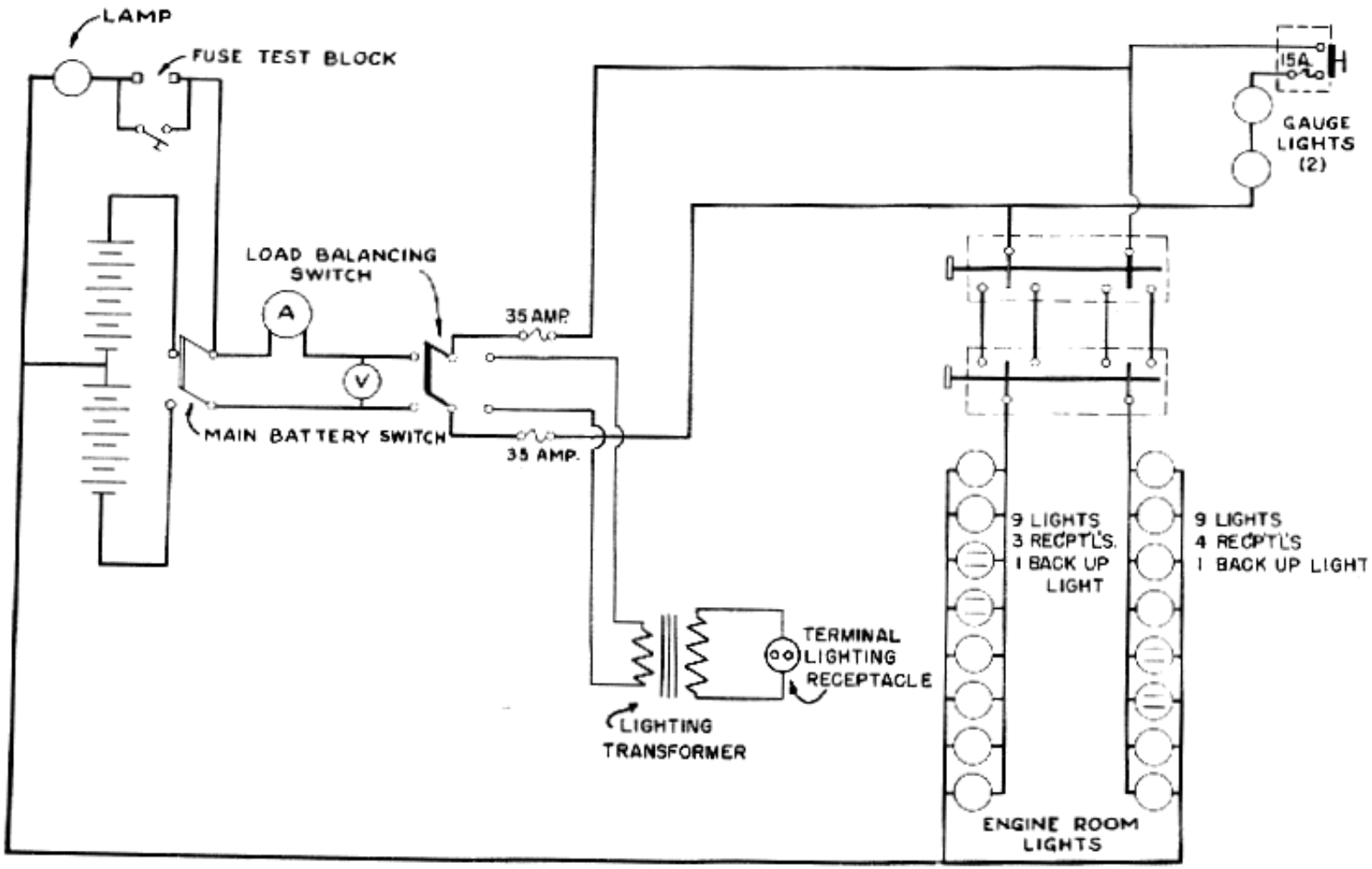
BATTERY CHARGING CIRCUIT
PLATE 2264

December 1940



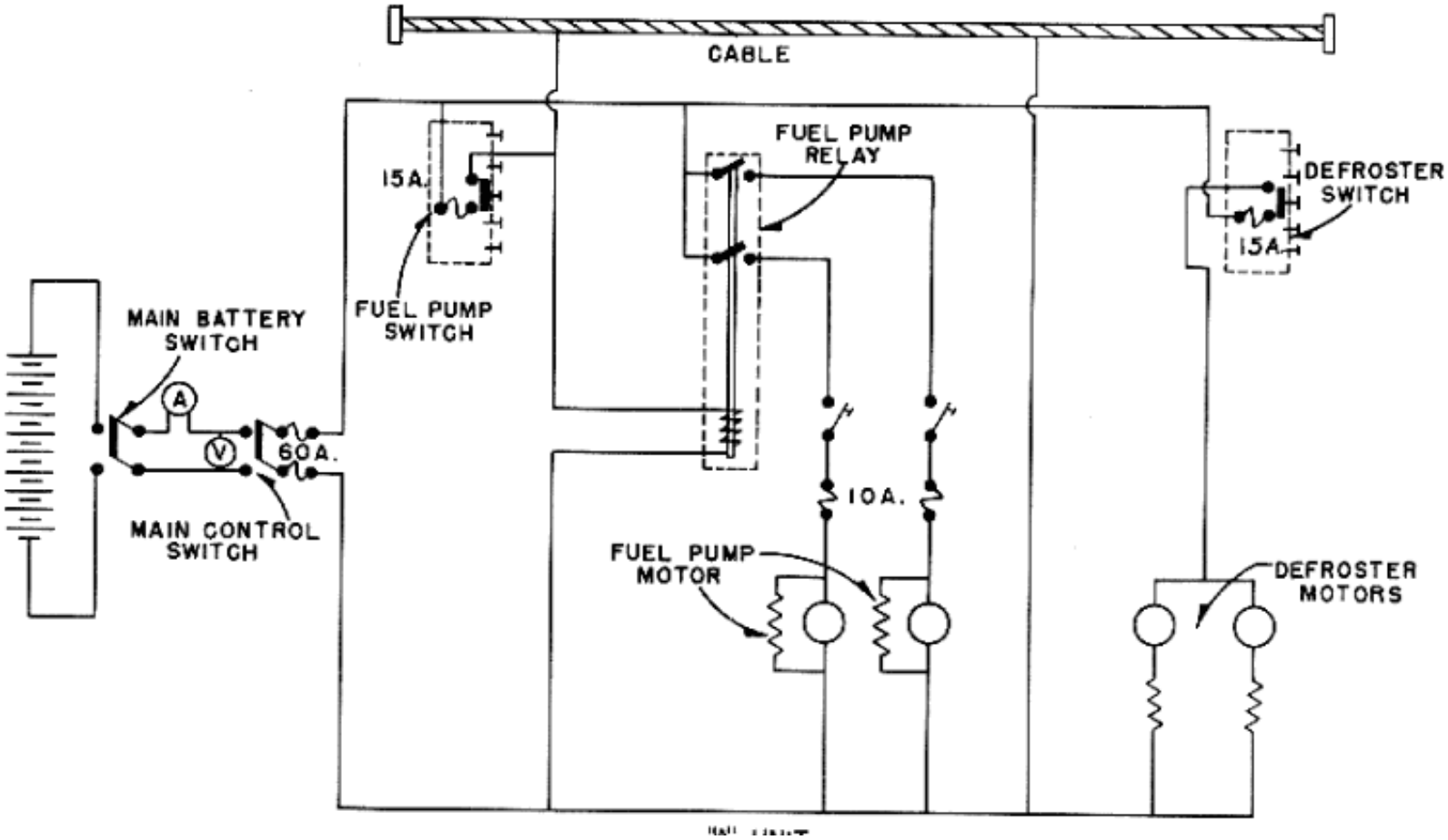
LIGHTING CIRCUIT
"A" Unit
PLATE 2269

December 1940



LIGHTING CIRCUIT
"B" Unit
PLATE 2270

July 1941

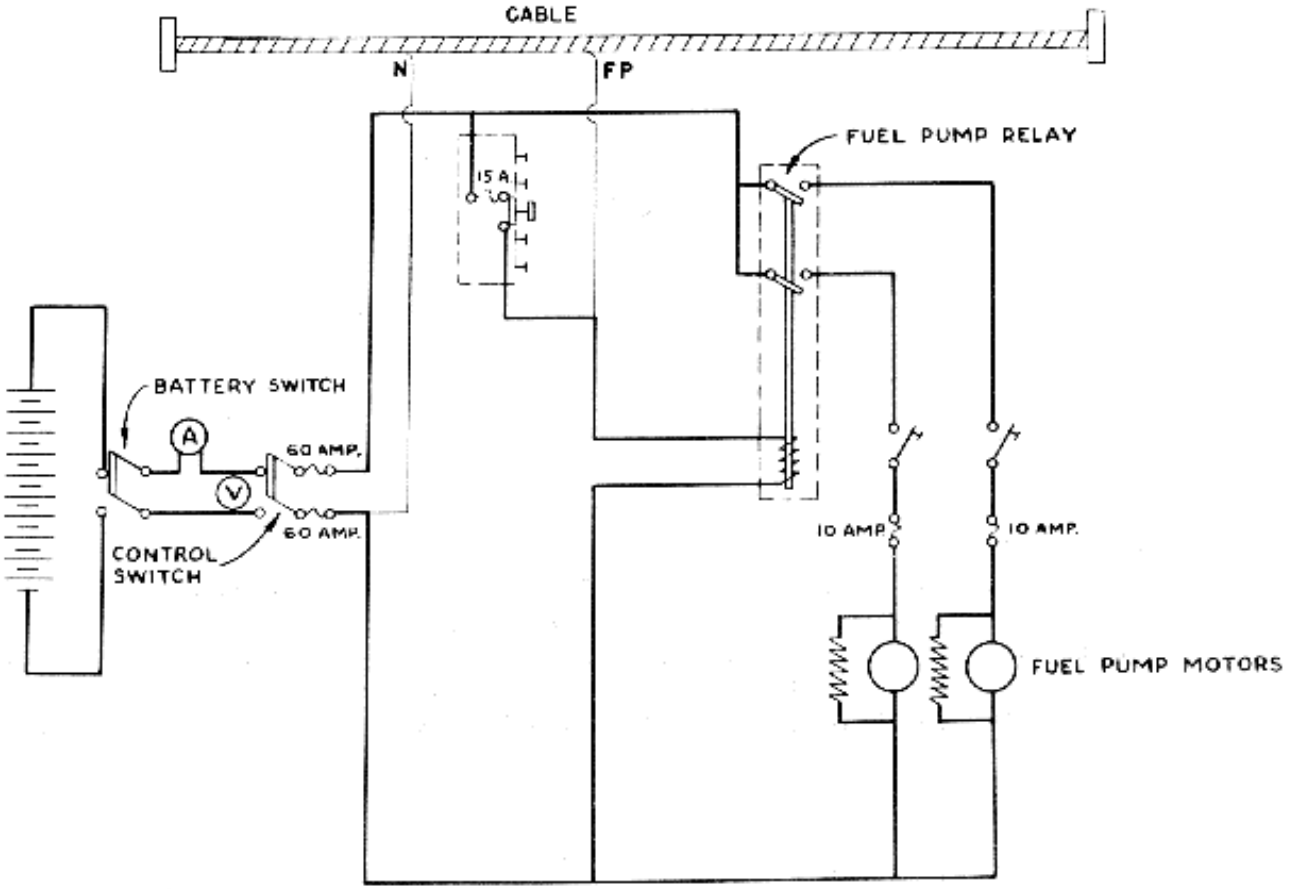


FUEL PUMP & DEFROSTER CIRCUIT
"A" Unit
PLATE 2284

March 1941

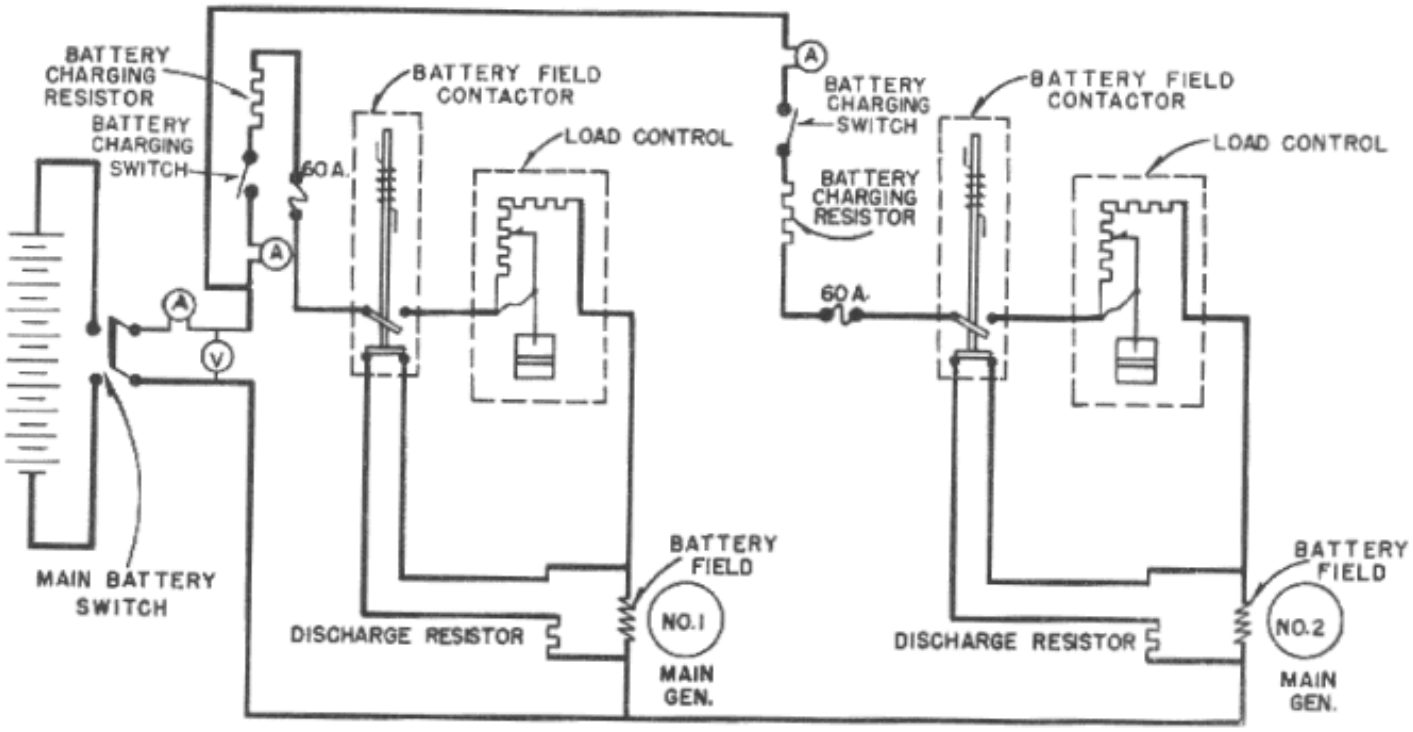
COMPLETE SCHEMATIC WIRING DIAGRAM
"A" Unit
PLATE 2271

July 1941



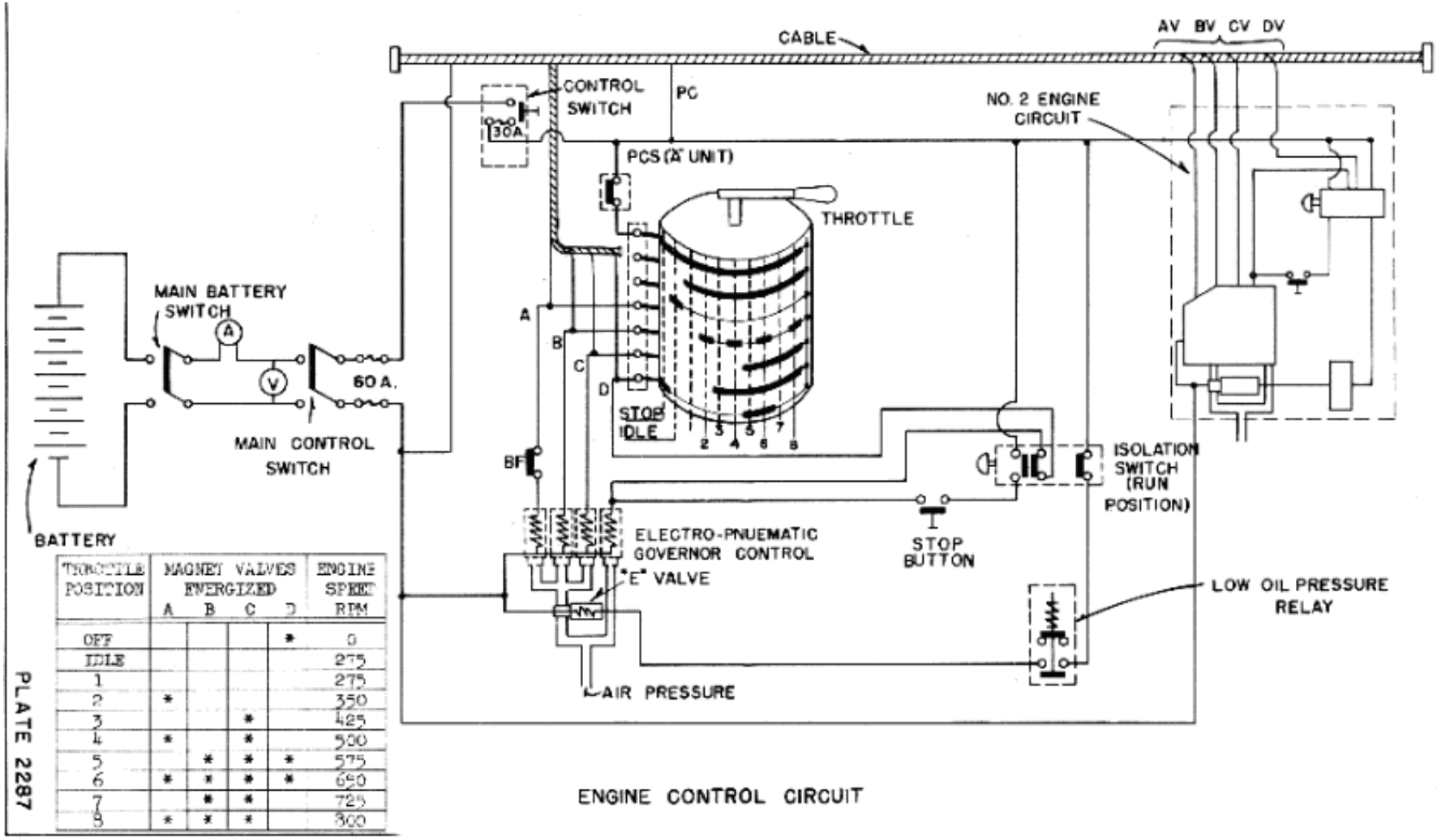
FUEL PUMP CIRCUIT
"B" Unit
PLATE 2302

March 1941



GENERATOR BATTERY FIELD CIRCUIT
PLATE 2285

December 1940



THROTTLE POSITION	MAGNET VALVES ENERGIZED				ENGINE SPEED RPM
	A	B	C	D	
OFF				*	0
IDLE					275
1					275
2	*				350
3			*		425
4	*		*		500
5		*	*	*	575
6	*	*	*	*	650
7		*	*		725
8	*	*	*		800

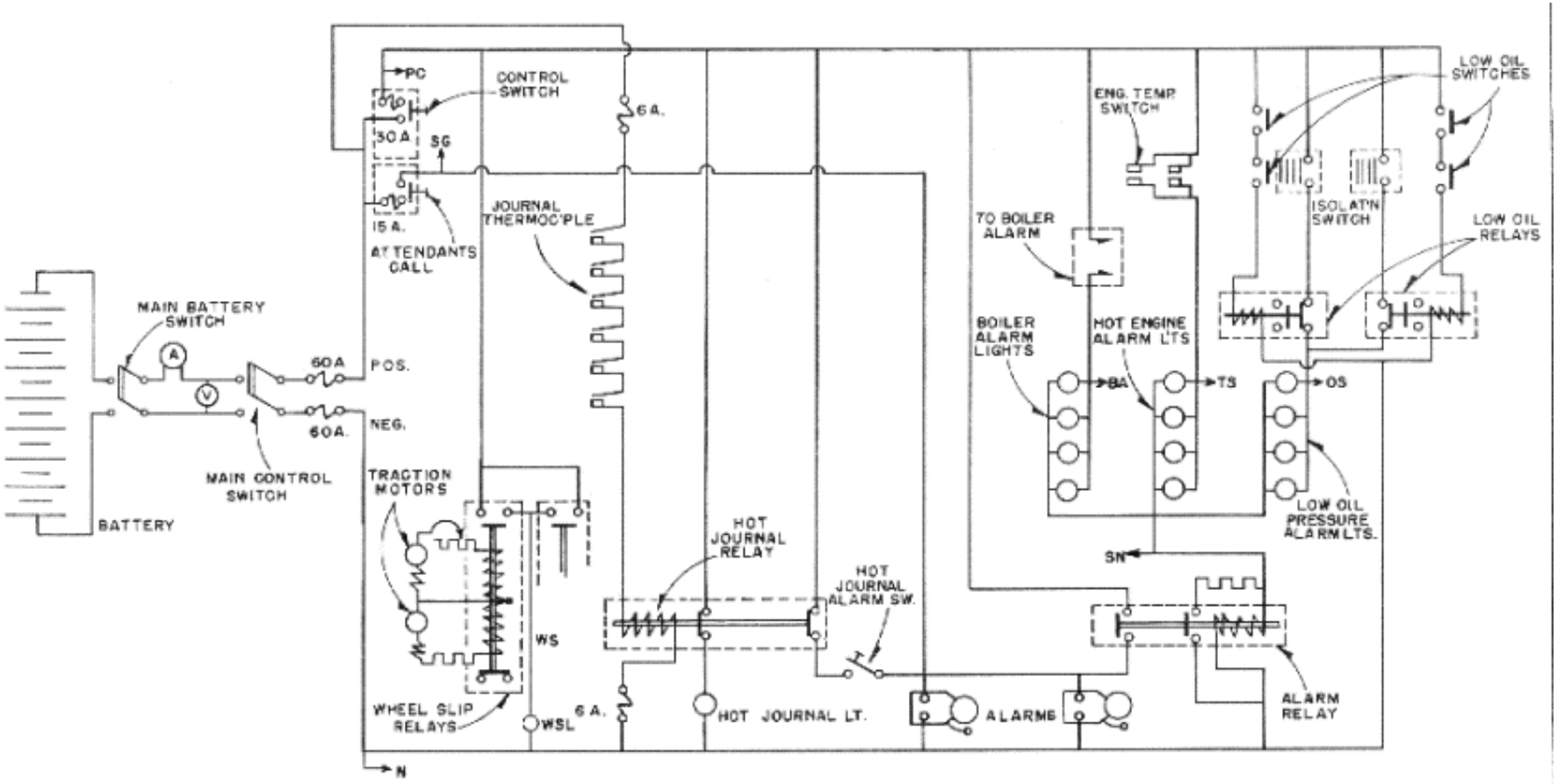
ENGINE CONTROL CIRCUIT

THROTTLE POSITION	MAGNET VALVES ENERGIZED				ENGINE SPEED RPM
	A	B	C	D	
OFF				*	0
IDLE					275
1					275
2	*				350
3			*		425
4	*		*		500

5		*	*	*	575
6	*	*	*	*	650
7		*	*		725
8	*	*	*		800

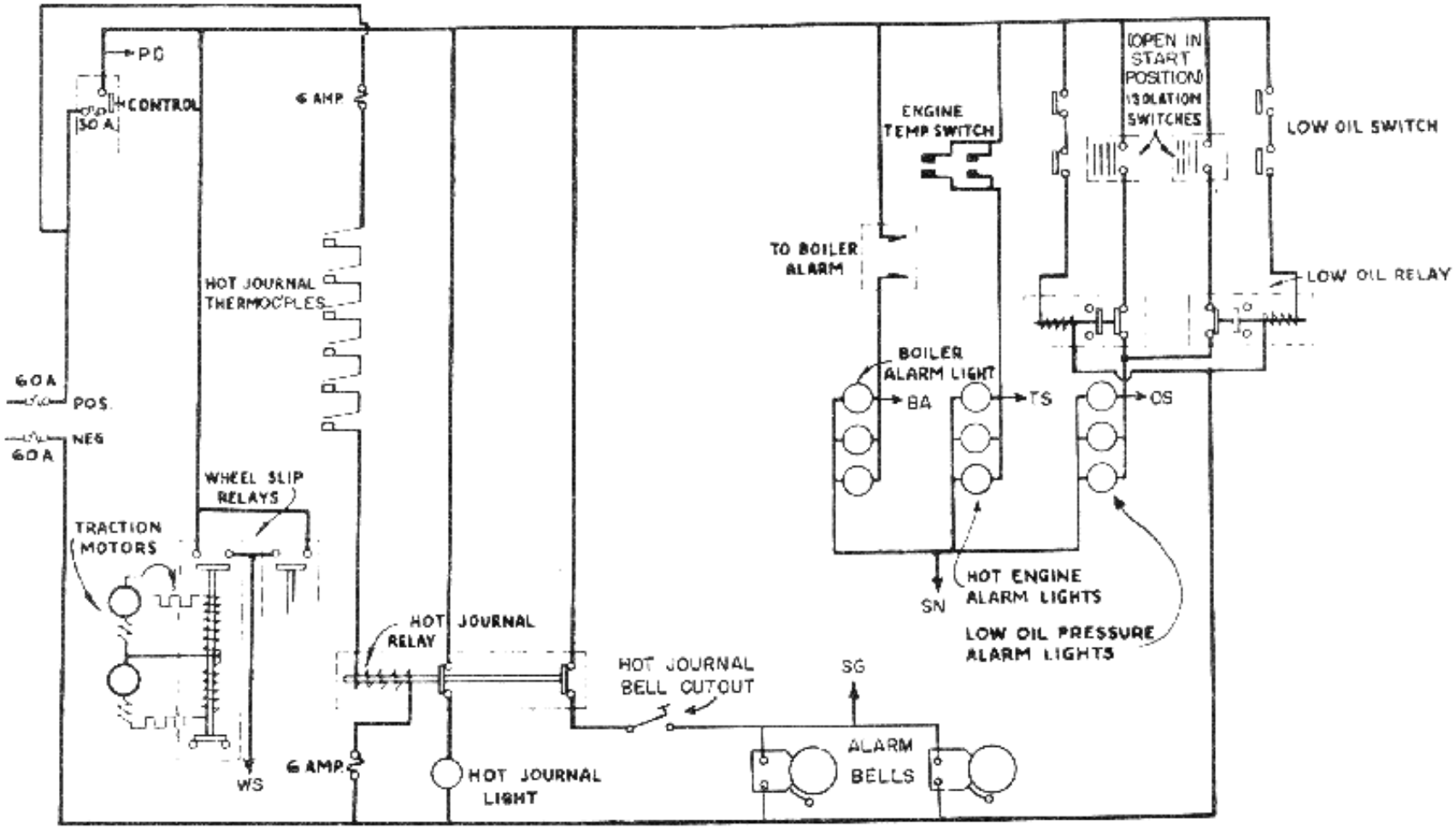
ENGINE CONTROL CIRCUIT
PLATE 2287

December 1940



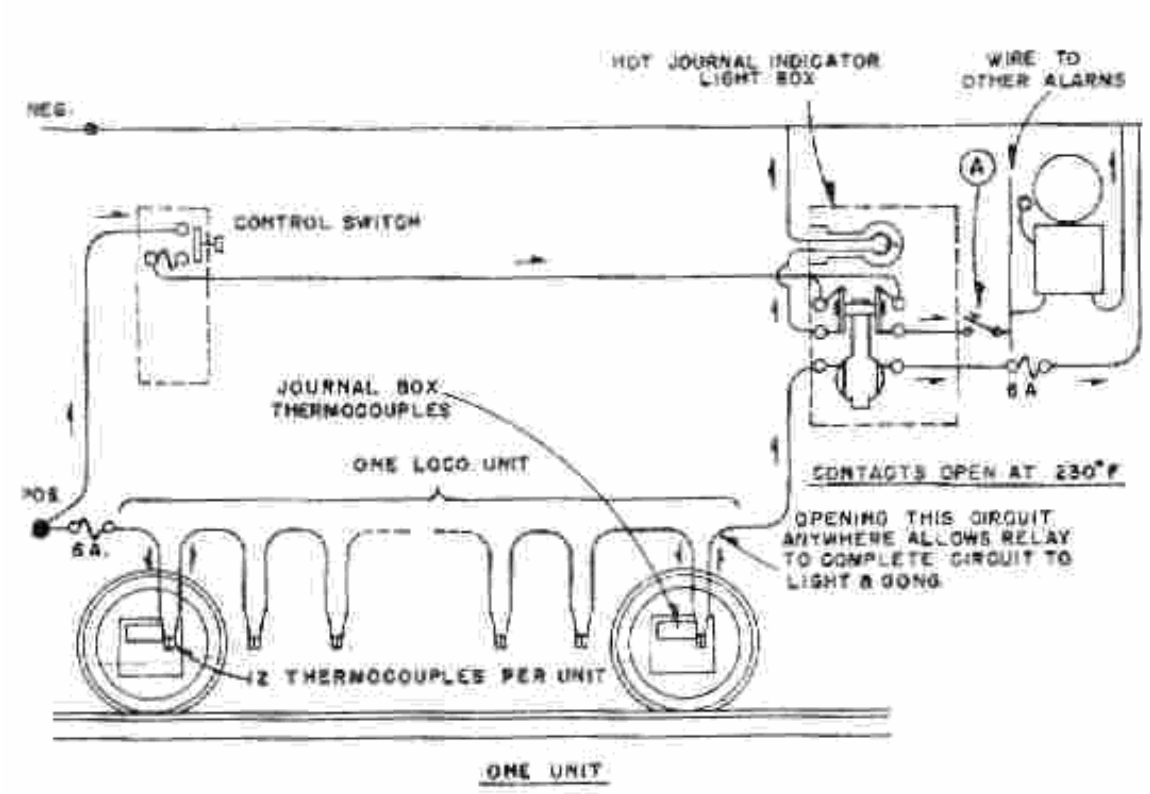
SIGNAL & ALARM CIRCUIT
"A" Unit
PLATE 2201

July 1941



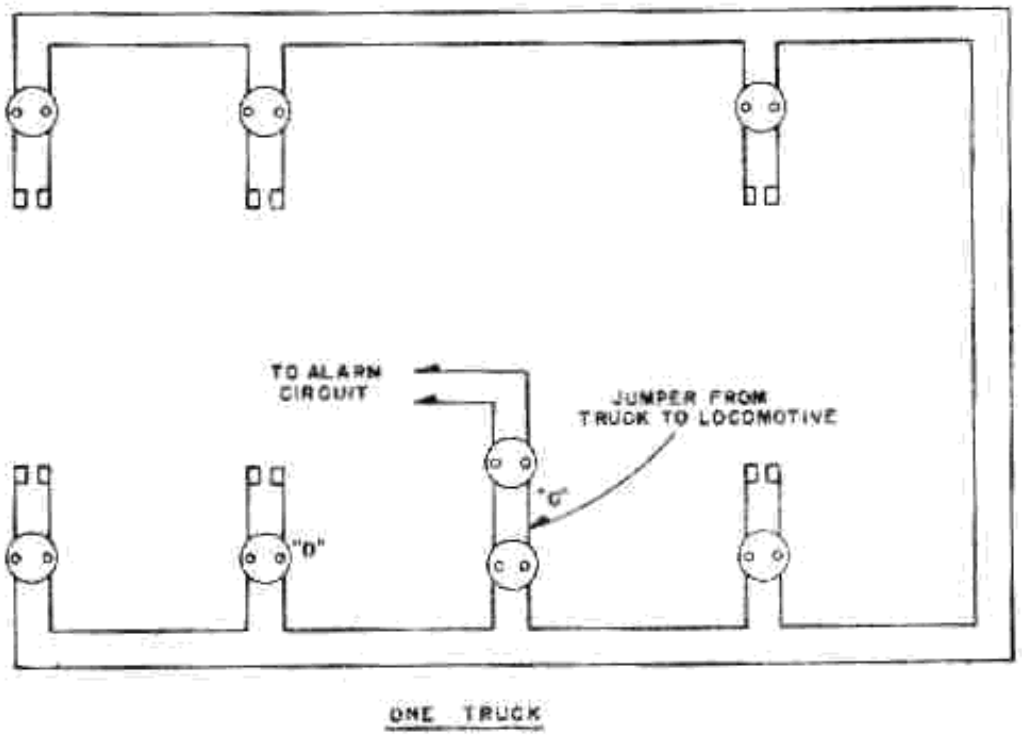
SIGNAL & ALARM CIRCUIT
"B" Unit
PLATE 2303

December 1940



SCHEMATIC WIRING DIAGRAM
JOURNAL THERMOCOUPLE CIRCUIT
ONE UINT
PLATE 2267

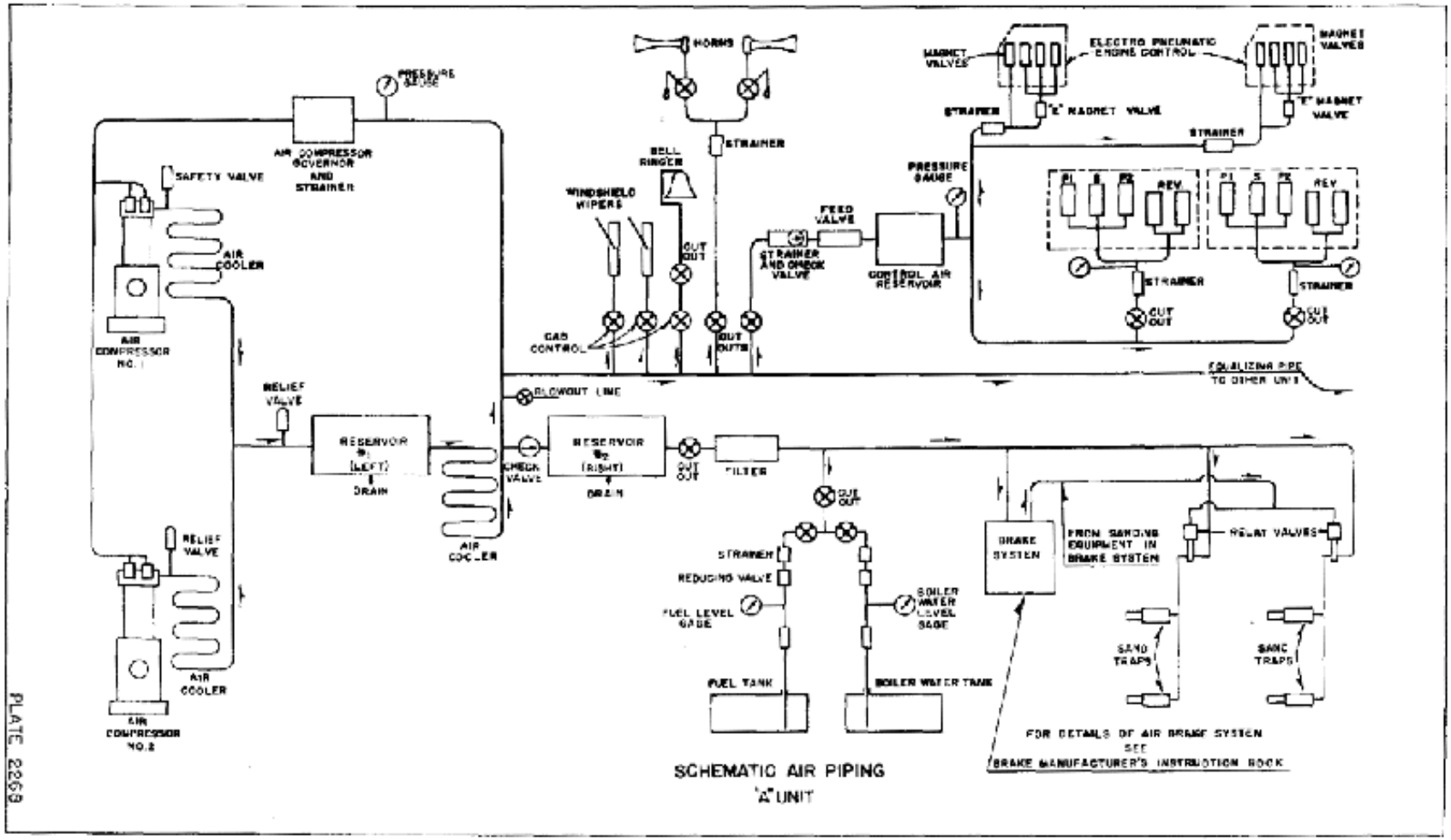
December 1940



ONE TRUCK

SCHEMATIC WIRING DIAGRAM
JOURNAL THERMOCOUPLE CIRCUIT
ONE TRUCK
PLATE 2267

December 1940



HIGH VOLTAGE CIRCUIT
PLATE 2268

January 1941

COMPLETE SCHEMATIC WIRING DIAGRAM
"A" Unit
PLATE 2271

July 1941

COMPLETE SCHEMATIC WIRING DIAGRAM
"B" Unit

PLATE 2271

July 1941

SECTION III

AIR SYSTEM

SANDING

See Bulletin 1206 for recommendations. Follow instructions given by your railroad. The sand capacity is 15 cubic feet for the "A" unit, none for the "B" unit. (Approximately 100lbs. per cubic foot is the weight of the sand). The operation of the sanding equipment should be checked every 10,000 miles.

AIR COMPRESSOR GOVERNOR

See Bulletin 1022 for maintenance.

The air compressor governor is set at the factory to maintain a main air reservoir pressure of 130-140#. This governor is sealed and the seal should not be broken by an unauthorized person as this will cancel any warranty on the air compressor. If it is suspected that the governor is stuck, and blowing it out by means of the pet cock at the bottom does not help, the condition should be reported.

Likewise the suction valves in the air compressor may be stuck which would require the help of the maintainer.

AIR COMPRESSOR - TYPE ADX

See Bulletin 1014 from maintenance.

The two stage, 2 cylinder air compressor is driven directly by the engine through a flexible coupling.

AIR COMPRESSOR FLEXIBLE COUPLING

See Bulletin 1010 for maintenance.

WINDSHIELD WIPERS

The sped of the wiper is controlled by the needle valve which turns it off and on. A new wiper blade should be installed when the rubber becomes worn or hard. Do not run the wiper on a dry window as dirt on the glass or blade will tend to scratch the glass.

Prestone is recommended as being best as a de-icing agent used in WINDSHIELD Wiper - Blades with fluid line. It flows readily and does not gum.

A mixture of one volume of Prestone to 4 volumes of water may be used as trial. However, if ice continues to form, use a more concentrated solution.

HORNS

If the horns are disassembled, note that the diaphragms are bowed and that this convex surface is installed toward the nozzle. Clean the horns before they become inoperative. There are three diaphragms in each horn. The strainer in the horn air line should be cleaned annually.

CONTROL AIR PRESSURE

The electric air pressure gauge is mounted on top of the high voltage cabinet. The air is delivered from the main reservoir to the voltage cabinet through a reducing valve filter and small expansion tank. The air filter should be cleaned annually.

If the electric air pressure gauge shows main reservoir pressure, the reducing valve is probably stuck. Blowing out the filter and expansion tank at the same time jarring the reducing valve, may correct this condition. If not, the maintainer should be called. The reducing valve is located to rear of the engine room near the expansion tank. Control air pressure should be maintained at 80 plus or minus 3#.

BELL AND RINGER

The bell, located in the space adjacent to the shutter, (one bell per unit) is operated remotely by an air type bell ringer. The bell can be reached for servicing either by removing the roof hatch over the bell or by reaching through the hatch below the bell.

AIR BRAKE EQUIPMENT

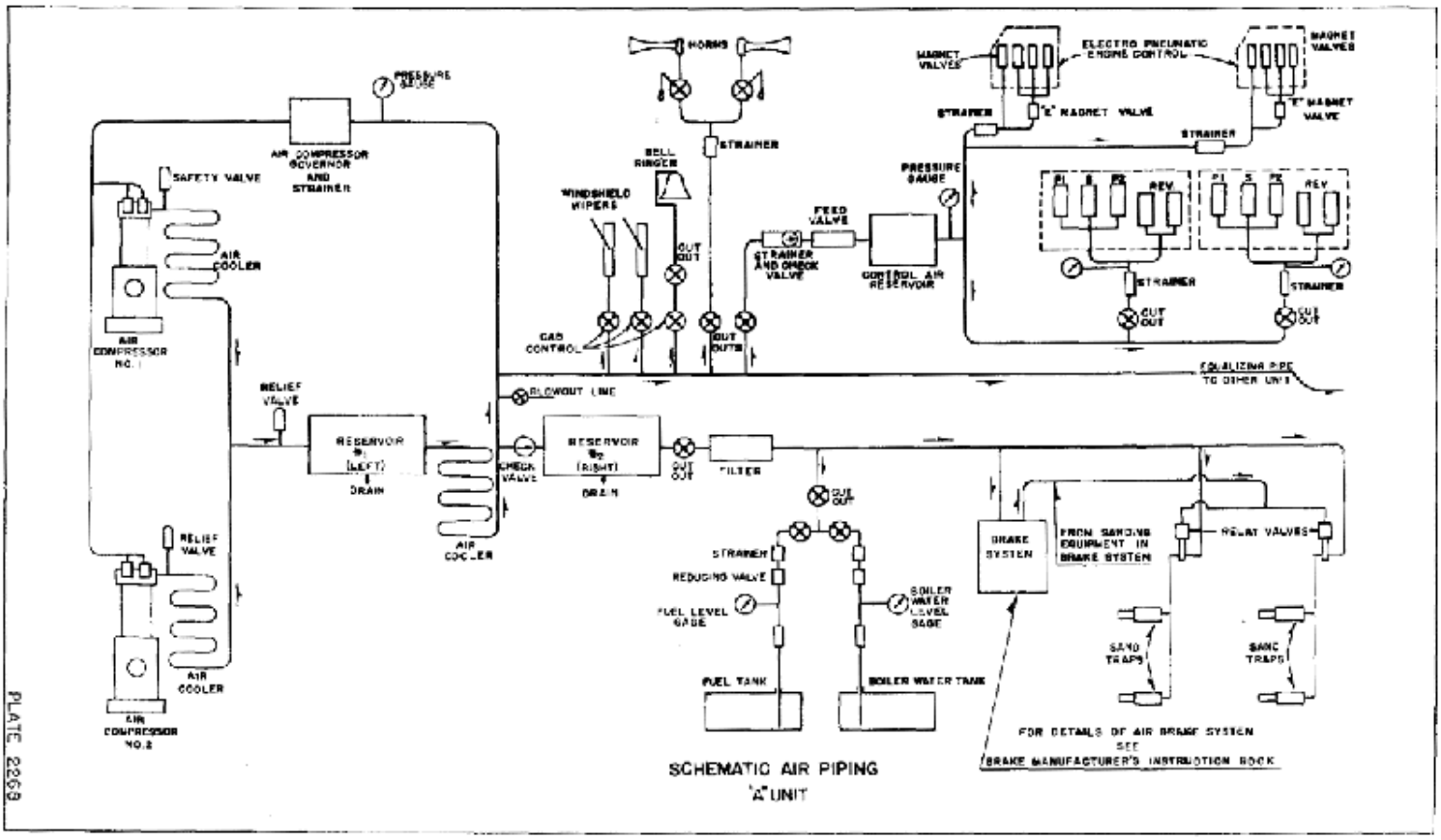
Refer to the instruction pamphlet supplied by the Westinghouse Air Brake Company for instructions on the operation of air brake equipment. This pamphlet includes piping diagrams and sectional drawings. The clasp brake should be adjusted as indicated on Plate 2318, in Section VII.

Refer to the train control manufacturer's instruction bulletin covering this particular locomotive for Automatic Train Control Instructions.

Every 10,000 miles check the condition of all air hoses and seals.

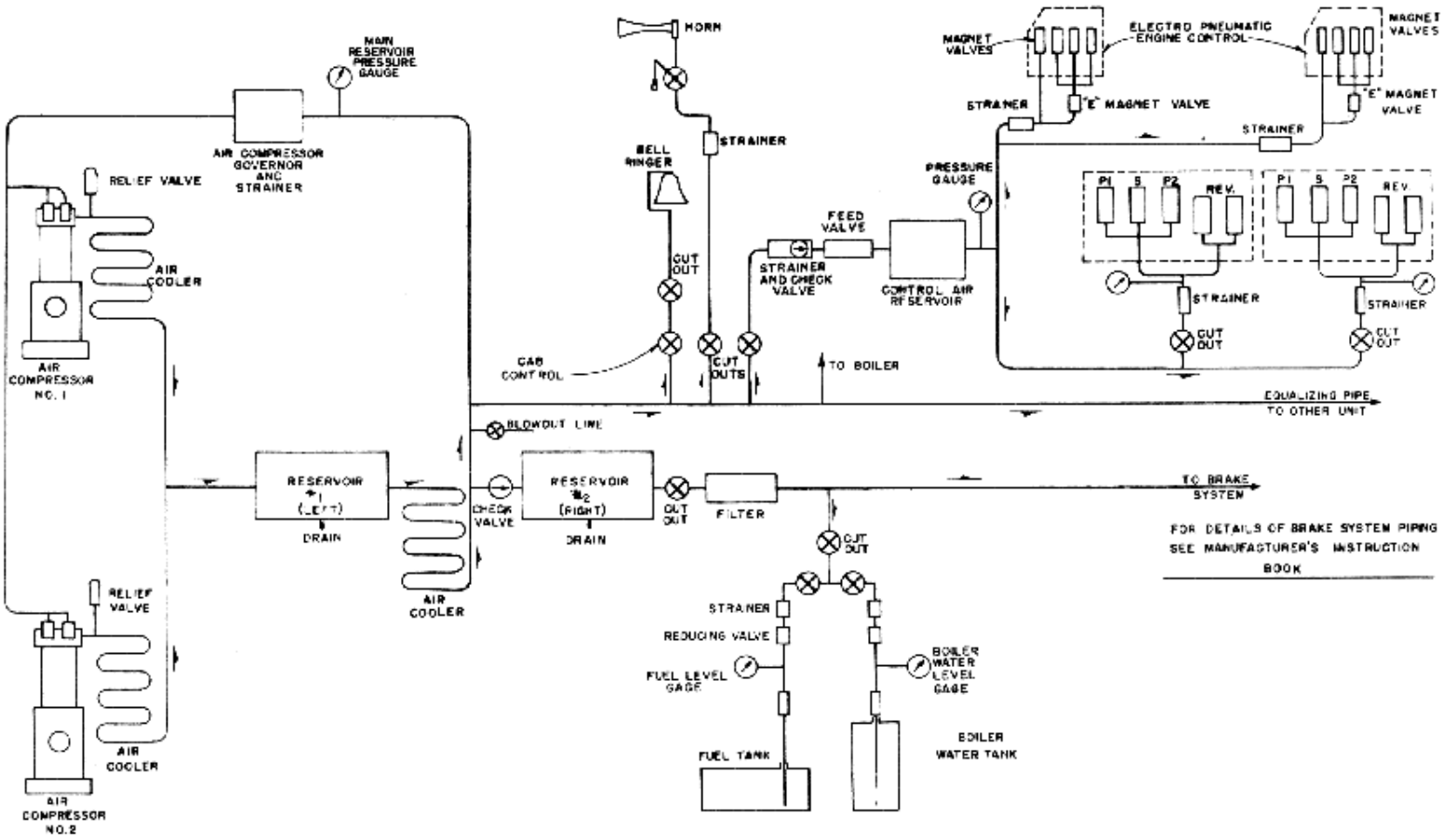
AIR FILTERS

Air filters and centrifugal dirt collections should be drained every 10,000 miles.



SCHEMATIC AIR PIPING
"A" Unit
PLATE 2268

December 1940



SCHEMATIC AIR PIPING
"B" Unit
PLATE 2328

December 1940

SECTION VII

BODY, CAB, TRUCKS and MISCELLANEOUS EQUIPMENT

HAND BRAKE

The hand wheel is located to the left rear of each unit. To set the brake, hold down the foot pedal and turn the wheel. To release the brake, advance the wheel enough to release the foot pedal and then let go and stay clear of the wheel. Before moving the locomotive, be sure the brake is completely released. Whenever anyone is working around the locomotive trucks, have the hand brake on.

MOUNTING WHEELS AND GEARS ON AXLES

Wheel to axle ..... 80 - 100 tons
Gear to axle ..... 55 - 85 tons

Wheels and gears should be inspected every 10,000 miles for thermal checks, thermal cracks and wear.

MOUNTING PINIONS ON TRACTION MOTORS

See the traction motor instruction bulletin 1119 for recommended procedure.

PULLING PINIONS

See bulletin 1118 for recommended procedure.

DOOR SAFETY GATES

At each side door and end door is a bar which should be lowered and latched in place whenever the door is opened when the locomotive is in motion.

ENGINE SAFETY GRILLS

Along each side of each engine is a grillwork which serves two purposes. When raised and latched in place it offers protection from the hand hole covers blowing off if a crankcase explosion occurred. When lowered the grills raise the level of a workman to facilitate working on the cylinder heads.

BELT SAFETY GUARDS

"V" belt guards should be in place whenever a power plant is rotating. See that the guards do not rub on the belts or vibrate loose.

TRUCKS

The 6 wheel trucks should be inspected every 100,000 miles for wear as indicated on Plate 2317. Trucks are interchangeable. The end of the truck frame which has the drop in it is always toward the outside end of the unit. Axles and journal boxes are not all interchangeable due to speedometer and speed governor drives. The journal box covers must be exchanged if the trucks are moved from front to rear, or vice versa. Make a visual inspection of the trucks every 10,000 miles. See Bulletin 1702.5 for truck tools.

TRACTION MOTOR BLOWERS

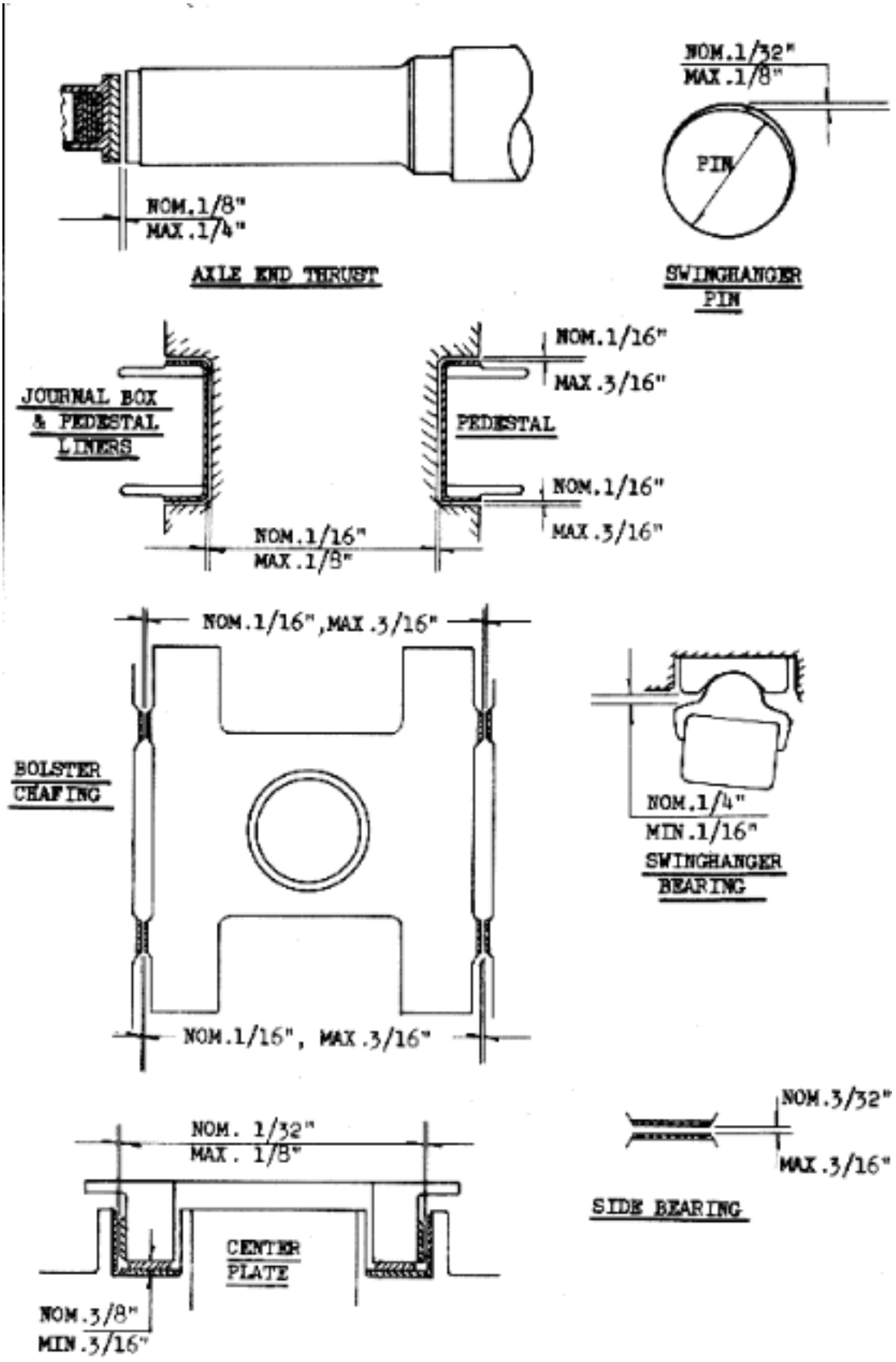
Since the traction motors depend on the traction motor blowers for ventilation, it is imperative that the traction motor blower drive belts be kept in good condition and under the proper tension.

Two traction motors depend on each blower and the cost of maintaining the belts is such a small item in comparison to the cost of repairing motors after they have been overheated and thrown solder, not to mention the damage to the winding, the particular attention should be paid to see that the belts are not slipping.

The blower turn at 2583 RPM when the engine is at 800 RPM.

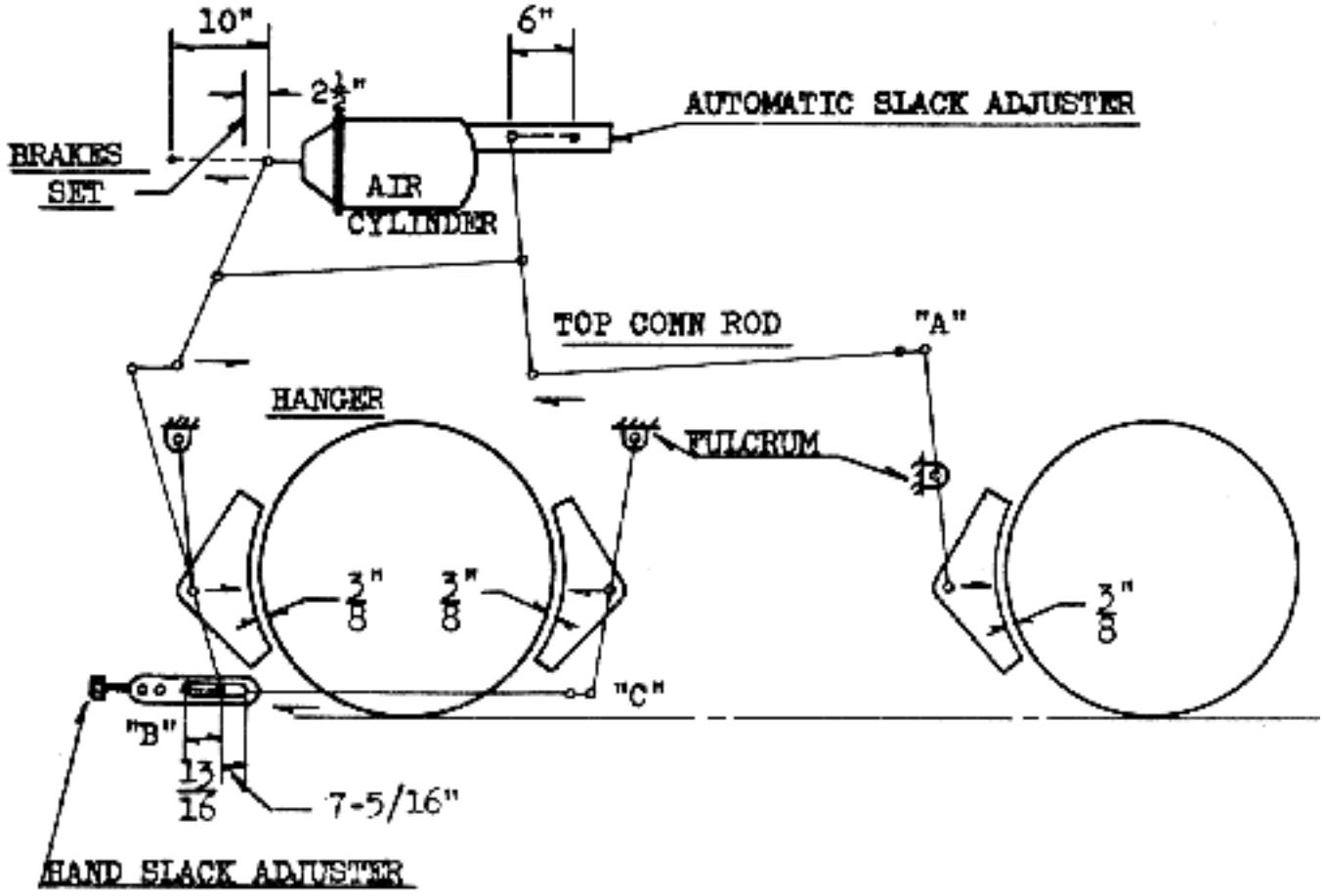
"V" BELTS

All "V" belts should be inspected every 10,000 miles for wear and adjusted to the proper tension if necessary. The belts must not ride on the bottom of the groove or be loose enough to slip or whip. See Bulletin 904 for repair information on belts.



WEAR LIMITS - SIX WHEEL TRUCK WITH EMC-HYATT JOURNAL BOXES
PLATE 2317

March 1941



Above diagram shows conditions for New wheels and Shoes.

AT ROUND HOUSE

As wear occurs, shift Pin a "A" from OUTSIDE to INSIDE hole and at "B" from OUTSIDE to INSIDE hole.

ON ROAD

As wear occurs, this should still leave full slackadjuster travel for the automatic take up and most of the hand slackadjuster take up.

It is important that allowances be made for take up on road at these two points.

When wheels are turned, adjust at point "C" above OUTSIDE to INSIDE hole, and others to suit as above.

NOTE: Point "C" can not readily be adjusted on road or at roundhouse.

At hand slackadjuster "B" 13/16" is required for applying new shoes.

BRAKE ADJUSTMENT - 6 WHEEL TRUCK
PLATE 2318

SECTION VIII

LUBRICATION POINTS

DIESEL ENGINE	
Lubricant:	Engine Oil
Quantity & Frequency	Add oil as required to keep proper level in tank. Change oil every 25,000 miles of service.
Capacity	Completely dry system..... 110 gallons Required to change oil .... 100 gallons
Instr. Bul.:	150.
ENGINE AIR FILTER	
Lubricant:	Engine Oil
Quantity & Frequency:	Wash element in a petroleum solvent and blow dry with compressed air. Dip in clean engine oil and drain for 12 hours in a warm room. Repeat whenever dirt is noticeable. Once week should be enough.
Instr. Bul.:	150.
ENGINE GOVERNOR	
Lubricant:	Engine Oil
Quantity & Frequency:	Add oil as required to keep level to mark on sight glass. Change oil every six months.
Capacity:	3 pints.
Instr. Bul.:	150.
ENGINE WATER PUMP	
Lubricant:	Engine Oil
Quantity & Frequency:	Fill the oil cup once each month.
Inst. Bul.:	150.
GOVERNOR CONTROL	

Lubricant:	Engine Oil
Quantity & Frequency:	Keep water saturated in oil reservoir
Capacity:	14 Quarts
Instr. Bul.:	1014
COOLING FANS	
Lubricant:	Engine Oil
Quantity & Frequency:	Remove top (breather) and side (level) plugs. Fill through top plug until oil runs out of side plug. This should be done monthly.
Capacity:	1-1/2 pints (approx.)
AIR COMPRESSOR FILTERS	
Lubricant:	Engine Oil
Quantity & Frequency:	Wash in a petroleum solvent and dip in new oil as inspection indicates.
Inst. Bul.:	1014
GOVERNOR LINKAGE	
Lubricant:	Ball Bearing Grease
Quantity & Frequency	Lubricant sparingly each week.
MAIN GENERATOR	
Lubricant:	Lubrico M-6 and Texaco Marfax No. 3.
Quantity & Frequency:	Add not more than one ounce of grease per month or 2 oz. every 15,000 miles. Do not over-lubricate. Texaco Marfax No. 3 for grooves in bearing cap.
Capacity:	34 ounces (approximately)
Inst. Bul.	422
TRACTION MOTOR ARMATURE BEARINGS	
Lubricant:	Lubrico M-6
Quantity & Frequency:	Add not over 2 ounces of grease per bearing every 25,000 miles. Base amount by experience. Do not over-lubricate.

Capacity:	Pinion end 20 ounces. Commutator end 15 ounces.
Instr Bul.:	1119.
TRACTION MOTOR AXLE BEARINGS	
Lubricant:	Electric Car Oil - Heavy for summer - Light for winter
Quantity & Frequency:	Add every 2,500 miles to keep level between 2" - 5"
Capacity:	5 Quarts
Instr. Bul.:	1119
TRACTION MOTOR GEARS	
Lubricant:	Texaco Crater Compound #2 for winter, #5 for summer or National Refining Winter or Summer grade.
Quantity & Frequency:	Keep bottom teeth of driver gear covered to a depth of 3". Determine by inspection.
Capacity:	14 lbs.
Instr. Bul.:	1119
TRACTION MOTOR BLOWER	
Lubricant:	Ball Bearing Grease
Quantity & Frequency:	Add small quantity monthly
JOURNAL BOXES	
Lubricant:	Journal box oil
Quantity & Frequency:	Fill to filler hole level every week.
Instr. Bul.:	1209
AUXILIARY GENERATOR	
Lubricant:	Ball Bearing Grease
Quantity & Frequency:	Once a year disassemble and repack 1/2 full.
Capacity:	3-1/2 oz. each bearing
Instr. Bul.:	421
TRUCK CENTER BEARINGS	

Lubricant:	Weekly add enough oil to soak up waste.
COUPLERS	
Lubricant:	ARA Specifications M-906
Quantity & Frequency:	Oil to keep parts working and present rust.
SHOCK ABSORBER	
Lubricant:	Delco Shock Absorber Fluid
Quantity & Frequency:	Keep filled to overflow plug.
SHOCK ABSORBER LINKAGE	
Lubricant:	Graphite Grease
Quantity & Frequency:	Lubricate monthly
CONTROL STATION BEARINGS	
Lubricant:	Light Oil
Quantity & Frequency:	Apply a few drops monthly to oil cups and bearings. Keep clean.
CONTROL STATION CONTACT FINGERS REVERSER CONTACT FINGERS	
Lubricant:	Petroleum Jelly
Quantity & Frequency:	Apply a small amount during breaking period.
AIR SHUTTERS & LINKAGE	
Lubricant:	Light Oil
Quantity & Frequency:	Lubricate sparingly each month. Keep clean.
FUEL PUMP MOTOR	
Lubricant:	Ball Bearing Grease
Quantity & Frequency:	Once a year disassemble and repack 1/2 full.
Instr. Bul.:	806
BOILER ROTARY CONVERTER	
Lubricant:	Ball Bearing Grease

Quantity & Frequency:	Grease sightly each month.
BOILER PUMP MOTOR	
Lubricant:	Ball Bearing Grease
Quantity & Frequency:	Turn grease cup one turn monthly.
BOILER PUMP BEARING	
Lubricant:	Ball Bearing Grease
Quantity & Frequency:	Turn grease cup one turn monthly.
HEADLIGHT DYNAMOTOR	
Lubricant:	Ball Bearing Grease
Quantity & Frequency:	Once a year disassemble and repack 1/2 full.
Instr. Bul.:	423
BOILER MAGNETO CAM & BEARING	
Lubricant:	U.S. 505 Bosch
Quantity & Frequency:	Lubricate only when repairing or annually
BOILER WATER PUMP	
Lubricant:	Marine Oil
Quantity & Frequency:	Keep filled to height of petcock. Change oil monthly
Capacity:	2 Quarts
BOILER PRESSURE SWITCH	
Lubricant:	Light Oil
Quantity & Frequency:	Oil moving parts every 3 months.
HAND BRAKE WHEEL	
Lubricant:	Light Oil
Quantity & Frequency:	Put a few drops on moving parts and through filer plug every six months.
BRAKE CYLINDERS	

Lubricant:	Light Oil
Quantity & Frequency:	Add a small amount of lubrication through filler plug every six months.
HAND BRAKE WHEEL	
Lubricant:	Light Oil
Quantity & Frequency:	Put a few drops on moving parts and through filer plug every six months.
WINDSHIELD WIPERS	
Lubricant:	Air Engine Oil
Quantity & Frequency:	Every 90 days lubricate the parts in the air chamber.
WINDSHIELD DEFROSTER	
Lubricant:	Light Oil
Quantity & Frequency:	Oil wick in motor every 50-100 hours of operation.
SPEEDOMETER GENERATOR	
Lubricant:	Ball Bearing Grease
Quantity & Frequency:	Annually insert small quantity in grease plug opening.
SLACK ADJUSTERS	
Lubricant:	Lubrico M-6 and Engine Oil
Quantity & Frequency:	Keep mechanism well lubricated and working freely. Apply grease to grease fitting and oil through oil hole.
COMPRESSOR DRIVE COUPLING	
Lubricant:	Velox Grease No. 2
Quantity & Frequency:	Add grease monthly. Keep coupling filled. Repack coupling annually.
Instr. Bul.:	1010
FAN IDLER	
Lubricant:	Ball Bearing Grease
Quantity & Frequency:	Adds small quantity monthly. Do not over-lubricate.
FAN JACK SHAFT	
Lubricant:	Engine Oil

Quantity & Frequency:	Keep level to side plug.
REVERSER	
Lubricant:	Ball Bearing Grease, Air Engine Grease, SAE 30 Oil and Petroleum.
Quantity & Frequency:	Add Ball Bearing Grease sparingly annually at two grease points. Add SAE 30 oil sparingly every three months at oil reservoir. Apply air engine grease on cylinder walls when overhauling. Wipe petroleum jelly on main contacts to prevent cutting.
Instr. Bul.:	1316
POWER SWITCHES	
Lubricant:	Air Engine Grease, and light oil
Quantity & Frequency:	Apply grease on cylinder walls annually, add few drops of oil when push rod comes out of cylinder.
Instr. Bul.:	573
VOLTAGE REGULATOR	
Lubricant:	Light Oil
Quantity & Frequency:	Do not lubricate the commutator or the sector. Each of the two sector bearings requires one drop of oil approximately once in two months. The torque motor ball bearing should be oiled, once in six months. Check the dashpot periodically to be sure it is free of dirt which might cause friction.
Instr. Bul.:	570
MISCELLANEOUS HARDWARE	
Lubricant:	Light Oil
Quantity & Frequency:	Keep cab seat, door latches, windows, etc., oiled but clean.
BATTERY TERMINALS	
Lubricant:	Petroleum Jelly
Quantity & Frequency:	Keep terminals from corroding by covering them with Petroleum Jelly.
DIAPHRAGM CENTER DEVICE	
Lubricant:	Pressure Gun Grease
Quantity & Frequency:	Lubricate daily the two pin type grease fittings. One fitting is in the end of bolt on diaphragm end of spring plunger. Second fitting is back of spring seat.
BOILER FUEL CONTROL SWITCH	

Lubricant:	Dashpot Oil
Quantity & Frequency:	Clean out dashpot and change oil monthly.
LOWER CENTER STEM	
Lubricant:	Pressure Gun Grease
Quantity & Frequency:	Lubricate daily. Do not allow dust to accumulate. Two pin type grease fittings; one in side of outer tube, second in outside end.
TEMPERATURE AND PRESSURE SWITCHES	
	The mechanism in these switches should be kept clean and free from dirt, dust, and any other accumulation. If any lubricant is used, it should be light oil (SAE 10). However, it is of the utmost importance that these switches be kept absolutely clean at all times.
BELL RINGER	
Lubricant:	Thin Oil
Quantity & Frequency:	Put a few drops of oil in oil holes monthly.
SPEED RECORDER	
Lubricant:	Fill oilcups (2) monthly with SAE 10 oil.
Quantity & Frequency:	Fill sight glass oil cup to 1/8" below top with circulation oil. Check weekly. Use wrench #779435 to remove cap. Fill conduit oil cup with "Car Oil". Use warm oil for filling empty cable. Keep filled. Grease button head fittings on drive unit weekly.

SUMMARY OF LUBRICANTS USED

The following list gives the part numbers of lubricants called for in the preceding pages.

EMC NUMBER	LUBRICANT
8047696	Lubrico M-6 Pressure Gun Grease BALL BEARING GREASE (Any of the following five greases can be used here)
8035762	Socony BRB-2 Ball Bearing Grease
8035763	Superla #2-X Ball Bearing Grease
8035764	Starfax#2

8035765	Keystone #45
8035766	Na-Re-Co "B"
8067551	Dashpot Oil
8047695	Air Engine Oil or Neatsfoot Oil
8027472	Petroleum Jelly
8047698	Texaco Marfax #3
8047699	Texaco Crater Compound #2 (Winter)
8043489	Texaco Crater Compound #5 (Summer)
8067348	National Refining "Na-Re-Co El. Ry. Gear" Grease (Winter)
8067349	National Refining "Na-Re-Co El. Ry. Gear" Grease (Summer)
8042777	Velox Grease #2
8047794	Graphite Grease
8044505	U.S. 505 Bosch Grease
8047792	Delco-Shock Absorber Fluid
8039278	Electric Car Oil
8035357	Marine Oil
8035772	Journal Box Oil - Socony AYCA-Y, or
8047717	Journal Box Oil - Texaco 1559

COMMERCIAL MARKET

Engine Oil (For Specification see Bulletin 150, 115A or 118A)

SAE 10 Oil

SAE 20 Oil

Light Oil

Brake Cylinder Oil

SECTION IX

QUESTIONS AND ANSWERS

COOLING SYSTEM

Q. How is the engine cooling system filled>

A. The engine cooling system is filled through the filler pipe in the car roof, or through one of the two filler pipes, or along the side.

Q. How much water should be carries in the engine cooling system?

A. Fill until overflow from stand pipe appear when operating in warm weather. Approximately 190 gallons will be required per engine at "high level". In freezing weather, open the "low level" valves and fill the cooling system until water runs out. Approximately 160 gallons will be required for the "low level".

Q. How can it be determined if water is circulating properly?

A. The engine water thermometers and temperature gauges provide an excellent means of showing a faulty water circulation or lack of water. Behavior of the water column in the water tank glass with engine running also provides indication of poor water circulation. For a given engine speed this water should show no spasmodic changes in the water glass. Poor water circulation is also indicated by excessive localized heating at various points in the cooling system. This may be determined by holding hand at various points in question and making comparison in degree of heat at various places.

Q. What is the proper operating temperature for the cooling water?

A. 165 degrees F.

Q. What precautions should be taken during layover periods in freezing weather?

A. During layover periods in freezing weather, particular precaution should be taken that the engine cooling water is heated or drained.

Q. If the engine should overheat on account of insufficient water in the cooling system, what should be done?

A. The engine should be allowed to idle and hot water, if possible, should be added. If it is necessary to add cold water, it should be added very slowly.

LUBRICATING OIL SYSTEM

Q. How much oil should be carries in the engine lubricating system? How low can the level go in emergencies?

A. The tank should be full to at least "1/2"full mark on the bayonet gauge when the engine is running. In emergencies the level can go to the low mark on the bayonet gauge.

Q. What special method is used to assist piston cooling? How is the wrist pin lubricated?

A. Cooling oil for the piston is delivered by a nozzle at the bottom of the liner. In addition to cooling the ribbed bottom surface of the piston head the oil drains down and lubricates the wrist pin roller bearing and the wrist pin bushings in the piston.

Q. What trouble should be looked for if oil pressure does not build up to proper pressure after the engine is started?

A. Check to determine if oil supply is low. Examine pressure regulating by-pass valve, pressure gauge, and oil pump.

FUEL OIL SYSTEM

Q. When and hoe should fuel oil stainers, on the engine, be cleaned?

A. They should be cleaned about every three months, by washing them in a petroleum solvent, forcing clean, dry compressed air through the screens, and wiping with lint-free rags.

Q. Describe how the fuel is delivered from the tanks under the car to the unit injectors on the engine.

A. Fuel is taken from the main tank under the floor through a line to a wire-wound filter mounted under the fuel pump in the engine room. It flows through this filter to the intake side of the fuel pump, then out of the discharge side of the pump to the duplex cloth fuel filter; through the filter on a manifold mounted on each bank; then to the unit injector where it goes through another filter located inside the injector body.

Q. If fuel should not get to the injector, what trouble should be looked for?

A. See that there is sufficient fuel in the tanks. See that the fuel pump is running and fuel pressure is up. Check battery and fuel pump fuses. Check to see if the lines are leaking air or fuel. Check oil filters and strainers.

Q. How is the fuel supply shut off in case of accident or fire?

A. Fuel supply is shut off by pulling one of the emergency fuel cut-off pull rings.

ELECTRICAL SYSTEM

Q. What is the purpose of the reverse current relay?

A. To connect the auxiliary generator to the battery for charging and to prevent the battery from feeding back into the auxiliary generator if the generator voltage falls below battery voltage.

Q. What is the battery voltage?

A. Approximately 64 volts (when not charging).

Q. How can it be determined when a traction motor is damaged, burned out, or short-circuited?

A. Lack of power, jerking, ground relay opens a burning smell can be detected, or the load regulator is in the extreme minimum field position.

Q. Should the reverser handle be in any position other than that of the locomotive?

A. No. At no time should the reverser handle be shifted until the locomotive comes to a complete stop.

Q. What is the meaning of transition?

A. This term applies to the changing of the traction motor electrical connections from series to parallel or to shunt. This is done to obtain the desired tractive effort and speed within the voltage operating limit of the generator.

Q. In what electrical connection are the traction motors at various speeds?

A. Up to approximately 34 MPH the motors are in series. From approximately 34 MPH to approximately 80 MPH the motors are in parallel. Above 80 MPH the motors are still in parallel but their fields are shunted by resistors. This is called the shunt position.

Q. How is the main generator excited?

A. The main generator has a battery field which is connected to the battery for excitation. It also has a shunt field which uses the generator armature voltage. The generator will not operate unless these fields are connected to their respective sources of power.

Q. How is the auxiliary generator excited?

A. The auxiliary generator is a self excited machine, with a shunt field; that is the field is in parallel with the armatures.

Q. How many traction motors are there per engine and how many per locomotive unit?

A. There are two traction motors per engine and four per locomotive unit.

Q. Which side of the battery is grounded?

A. Neither side of the battery is grounded.

Q. What is the difference between the signal relay and the journal signal relay?

A. The signal relay operates when the *Journal, boiler out, hot engine, and low oil alarms* function. The journal signal relay operates only when there is a hot journal box.

Q. What is the time delay relay?

A. The time delay delays the closing of the "P1" contactor when transition occurs, giving the generator voltage time to stop, thus preventing arcing of contacts and generator commutator.

Q. What is the isolation switch?

A. The isolation switch is a two position control for each engine. In "start" position the engine is isolated from the traction motors making it possible to start or stop it. When in "run" position the engine is "on the line", supplying power to the traction motors and being controlled from the control station in the cab.

Q. Can an engine be stopped in an emergency by pulling the battery switch?

A. No. Pulling the battery switch will not cause the electrical equipment to become inoperative. The quickest way to stop an engine is by placing the isolation switch to "start" position and pushing the "stop" button. To stop the engines from the cab place the throttle in stop position or pull the fuel cut-off pull rings in emergency.

Q. What connection does the throttle and reversing handles have with the engine or electrical equipment?

A. The throttle handle simply makes electrical contacts to wires leading to the electro-pneumatic governor control. The throttle cannot affect engine speed unless control air pressure is up and the electrical circuits closed. The reversing handle simply connects to wires leading to the forward and reverse magnet valves on the reverser. Unless control air reassure is up and the electrical circuit closed, moving the reversing handle will have no effect on the locomotive.

Q. What is the load control?

A. The load control is a combination of a two way oil valve known as the pilot valve, a rheostat operated by an oil piston known as the load regulator resistors. Through the operation of the governor and governor control, the pilot valve allows oil to flow to the load regulator which inserts or cuts out resistance in the generator battery field circuit. This varies the load on the engine according to the demand or according to the engine's ability.

Q. What is the voltage relay?

A. The voltage relay (transition relay) causes the traction motors to make a transition. This relay operates on main generator voltage.

ENGINE OPERATION

Q. Explain the manner in which the engine is started by the battery?

A. It is merely a case of using the generator temporarily as a series wound motor with the storage battery furnishing the required energy.

Q. What is the reason for carrying a bar on a locomotive which can be used for slowly turning the engine over by hand and what precautions must be observed when it is used?

This bar or lever is used in turning the engine over when checking for condensation or adjusting valve lash adjustors, and injector timing.

A. Care should be taken in using this bar to prevent injury die to "back-kick" resulting from engine compression. Extreme care should be taken to remove this bar before starting the engine. Open cylinder compression test valves before barring over engine. These must be reset when engine is started. Have fuel pump off.

Q. If engine rotates, but dos not fire, how should one proceed to determine the trouble?

A. See that there is sufficient fuel in the supply tanks. See that the fuel pump switch is "in", that the pump is running and the pressures are correct on the fuel gauges. See that fuel is actually getting to the injector. Be sure compression valves are closed.

Q. After the engine has started, what precautions should be fireman take?

A. Be sure that engine oil pressures come up. If no pressure shows on a gauge, stop engine immediately. Be sure that engine cooling water is circulating properly. Do not attempt to load engine by moving train until engine has been thoroughly warmed up and the water outlet manifold temperature has reached 125 degrees F.

Q. What precautions should be taken in stopping engine?

A. Before stopping the engine it is a good practice to let the engine idle for about one minute or until the water temperature begins to drop.

Q. How is the engine stopped?

A. The engine will be stopped if the isolation switch is placed on "start" and the "stop" button is pushed. Hold button until engine comes to a complete stop.

Q. Explain how the exhaust valves are operated and give their functions?

A. There are four exhaust valves to each cylinder. Their purpose is that of releasing the burned gases fro the cylinder. They are operated by the camshaft through rocker arms. Their proper adjustment is held with the automatic lash adjusters which eliminate the necessity of checking valve clearance manually.

Q. Explain what should be done if an exhaust valve spring breaks on the road?

A. Install injector hold down clip. Tie valve having broken spring to rocker arm shaft with wire. If tools and spare springs are on the car, replace spring at terminal. Be sure when changing a valve spring to place piston on top center to prevent valve from dropping inside of cylinder.

Q. What precautions should be taken when installing a new exhaust spring or in freeing up a sticky valve stem? How is a sticky valve stem freed up?

A. The engine should be turned over until the piston in the cylinder with the broken valve spring or sticky valve stem is on its top center. This is to prevent valve from dropping into cylinder when spring is released. Use distillate or kerosens on valve stem that is stuck and work stem around up and down. For a badly stuck valve stem,, it is abvisable to remove valve spring as this makes valve stem more accessible. In order to remove a valve spring it is necessary to first remove the rocker arm and valve bridge assembly.

Q. Explain the purpose of the cylinder test valve.

A. The purpose of this valve is to test for an accumulation of oil or water in the cylinder.

Q. How and when should cylinders be checked for accumulation of oil or water in the cylinder.

A. If the engine has been idle for 8 hours or more all cylinder test valves should be opened and the engine turned over by hand at least one turn. Throttle must be closed and fuel shut off. In case any accumulation of water or fuel oil should be found in any cylinder, cause must be found before starting engine.

Q. How is the movement of the hand throttle transmitted to the injector valves?

A. Movement of the engineer's main throttle is transmitted to the governor control electrically. The governor control then operates the governor. The governor then controls the injector layshaft, which movement is transmitted to the injector control racks.

Q. Explain the action of the governor.

A. The governor gives the engine a definite sped for each throttle position.

LOCOMOTIVE OPERATION AND LUBRICATION POINTS

Q. Regardless of the completeness of the system of maintenance and inspection existing on the car, What inspection should be made by the fireman prior to starting?

A. Check the following:

- Supply of fuel, water, oil and sand.
- The various valves in the engine cooling and fuel systems for open or closed position in accordance with instructions.
- engine oil, air, and fuel pressure.
- Brakes: Is hand brake released? Do air brakes work properly?

Q. What is the last thing that an engineer should do before leaving the locomotive at the completion of his run when the car is not to be moved immediately under its own power?

A. The hand brakes should be set. All switches should be pulled, including all lights. The main battery switch should be pulled. This must not be forgotten.

Q. What should be done if there is possibility of car being handled by other power, such as switch engine, or being towed in train?

A. Main battery switch on panel board should be opened; close double head cut-out cock in brake system; and open "dead engine" 3/8 cut-out cock, put brake handle in running position.

Q. Explain what should be done in case a traction motor axle bearing runs excessively hot; and when it continues to run hot.

A. Check oil level, adding oil if necessary, at the oil well and also pouring considerable oil directly on top of the waster. Work waste about and over against the axle. If the bearing continues to run hot, back off nuts a slight amount on axle bearing cap bolts. See that packing is in good condition and not charred.

Q. What trouble may cause fans not to operate?

A. V-belts broken or too loose. Broken fan bearing or idler bearing.

Q. What troubles may cause the air compressor not to operate?

A. Internal trouble in the compressor, sticky valves, air compressor governor failure or a broke coupling.

Q. When should sand be used to stop a locomotive? Is sand harmful to the equipment? Why?

A. Sand should be used to stop a train only when tail conditions make its use absolutely necessary. This sand is harmful to the equipment inasmuch as a portion of it may be blown back and carried into the traction motors. The abrasive action of this sand is highly detrimental to the traction motors.